

**FINAL  
DETAILED PROJECT REPORT  
WITH ENVIRONMENTAL ASSESSMENT**

**SECTION 205 FLOOD DAMAGE REDUCTION STUDY**

**MAD CREEK  
MUSCATINE, MUSCATINE COUNTY, IOWA**



**US Army Corps  
of Engineers** ®  
Rock Island District

**NOVEMBER 2002**

**CEMVR-PM-M**

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## ACKNOWLEDGEMENT

Many members of the Rock Island District, U.S. Army Corps of Engineers assisted in the preparation of the Detailed Project Report (DPR) for Mad Creek located in the City of Muscatine, Muscatine County, Iowa. Primary team members who are familiar with the technical aspects of the project are listed below:

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**US Army Corps  
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Rock Island District

**WE'RE PROUD  
TO SIGN  
OUR WORK**



## EXECUTIVE SUMMARY

### **Mad Creek, Section 205 Flood Damage Reduction Study, Muscatine, Iowa Detailed Project Report with Environmental Assessment July 2002**

This Detailed Project Report (DPR) presents the results of a feasibility study of flooding problems along Mad Creek in the City of Muscatine, Iowa. The Rock Island District of the U.S. Army Corps of Engineers prepared an initial appraisal dated November 16, 1998 and initiated the feasibility study in March 2000. The study is authorized under Section 205 of the 1948 Flood Control Act, as amended.

The Mad Creek watershed drains approximately 17.3 square miles in the eastern portion of the City of Muscatine and areas to the north in Muscatine County. Due to the nature of the watershed and intensive development in the downtown area, Mad Creek is prone to flash flooding, experiencing flooding events in 1990 and 1993.

Throughout a feasibility study, the U.S. Army Corps of Engineers strives to inform, educate, and involve the many groups who may have an interest in the study. This coordination is paramount to assuring that all interested parties have the opportunity to be part of the study process. A public open house was held on April 11, 2000, in the City of Muscatine, Iowa. The study team used the feedback from the open house to develop and evaluate alternatives.

Alternative plans were developed and evaluated based on appropriate engineering, economic, environmental, cultural, and social factors. The selected plan is the alternative judged to have the greatest net economic benefit while being consistent with protecting the Nation's environment.

Alternative D-2 was identified as the selected plan. Major components include raising the height of approximately 2,300 linear feet of existing levees and 1,700 linear feet of existing floodwalls by approximately 2 feet, 230 linear feet of new floodwall, a new bulkhead closure gate to replace the existing panel closure at Mississippi Drive, a new overhead closure gate to replace an existing floodgate at 2nd Street, a new swing gate to replace the panel closure across the abandoned railroad just upstream on 2nd Street and installation of a new closure structure across the railroad south of Washington Street. Minor modifications to the existing pump houses and gatewells along the Mississippi River and Mad Creek may be required due to the increase in flood protection height. The selected plan also includes improving a section of the Mad Creek channel upstream of 2nd Street to reduce flood stages and installation of an enhanced flood warning system. The project cost estimate is \$3.45 million and the estimated benefit-cost ratio is 3.4 to 1.

The selected plan is satisfactory to the public, complies with United States law including appropriate environmental requirements, and meets all Corps of Engineers criteria. A recommendation is made by the District Engineer that the selected plan be constructed under the authority of Section 205 of the 1948 Flood Control Act, as amended, with such modifications as, in the discretion of the Chief of Engineers, may be advisable.



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**1. INTRODUCTION**

**a. General.** This Detailed Project Report (DPR) presents the results of an investigation of the flooding problems along Mad Creek in the City of Muscatine, Muscatine County, Iowa. The Rock Island District of the U.S. Army Corps of Engineers (the District) received a request in November of 1996 from the City of Muscatine, Iowa, to assist in investigating flood damage reduction measures along Mad Creek. The District performed field reconnaissance, met with city officials, prepared an initial appraisal dated November 16, 1998, and an addendum dated December 15, 1998. The feasibility study was initiated in March 2000.

**b. Study Authority.** The Mad Creek Flood Damage Reduction Study in the City of Muscatine, Iowa, is undertaken through the U.S. Army Corps of Engineers (Corps) Continuing Authorities Program (CAP). This effort is in response to requests for Federal flood protection assistance from officials of the City of Muscatine, Iowa. The study was authorized under Section 205 of the 1948 Flood Control Act, as amended.

**c. Study Purpose and Scope.** The purpose of the feasibility study is to determine if there is a Federal interest in a flood damage reduction water resources project within the area and to describe the scope and scale of such a project. This DPR documents analyses performed in previous and current studies and contains the recommendation for project (plan) approval.

**d. Type and Detail of Investigation.** This DPR summarizes the results of analyses in the areas of planning, hydrology and hydraulics, foundations and materials, engineering, economics, and natural and cultural resources. The study was conducted in sufficient detail to determine the feasibility of an economical flood damage reduction plan (project), recommending a selected plan for implementation. An environmental analysis and gross real estate appraisal were also conducted. This DPR contains sufficient project design detail to serve as a basis for preparing construction plans and specifications.

According to the results of the project's initial appraisal, four primary alternatives were considered for reducing flood damages:

- A.** Raise the existing levee/floodwall system and improve closures along Mad Creek only.
- B.** Construct two storm water detention dams in the Mad Creek and Geneva Creek watersheds.
- C.** Combination of Alternatives A and B.

- D.** Raise the existing levee/floodwall system and improve closures along Mad Creek and the Mississippi River in combination with channel improvements immediately upstream of the 2nd Street Bridge.

Additionally, all alternatives include installing an enhanced flood warning system on Mad and Geneva Creeks.

**e. Study Area.** The Mad Creek study area is located in the westerly watershed of the Mississippi River in the City of Muscatine, Muscatine County, Iowa (see Figure 1 on page 3). The Mad Creek watershed drains approximately 17.3 square miles in the eastern portion of the City of Muscatine and areas to the north of the City of Muscatine in Muscatine County. The upstream portion of the Mad Creek watershed, north of the City of Muscatine, is primarily agricultural land but is rapidly being converted into residential subdivisions and commercial developments. The lower portion of the Mad Creek watershed is located within the Muscatine city limits, flowing through an area of mixed commercial, industrial, and residential uses near the downtown area before emptying into the Mississippi River. Low-lying areas along Mad Creek and Geneva Creek, its main tributary, are subjected to flash flooding.

**f. Prior Studies, Reports and Existing Water Projects.** Studies and reports that are pertinent to this feasibility study include:

- (1) *General Design Memorandum for Muscatine, Iowa (Mad Creek) Local Flood Protection.* Rock Island District, U.S. Army Corps of Engineers. 28 May 1956.
- (2) *Detailed Project Report for Flood Control at Muscatine, Iowa under Provisions of Section 205 of the 1948 Flood Control Act, as amended.* U.S. Army Engineer District, Rock Island, Corps of Engineers. 9 September 1970.
- (3) *Mad Creek Muscatine, Iowa Local Flood Protection. Supplement No. 1 to the Detailed Project Report.* U.S. Army Engineer District, Rock Island, Corps of Engineers. 23 February 1981.
- (4) *Mad Creek, City of Muscatine, Muscatine County, Iowa Flood Mitigation Preliminary Investigation.* U.S. Department of Agriculture, Natural Resources Conservation Service. August 1996.
- (5) *Title 10 Zoning, Chapter 4 FP Flood Plain District,* City of Muscatine. March 3, 1988.
- (6) *City of Muscatine Revised Flood Control Manual, In Draft,* City of Muscatine. July 2001.
- (7) *Flood, June 16, 1990. Chronology of Events.* Ray Childs, City of Muscatine.

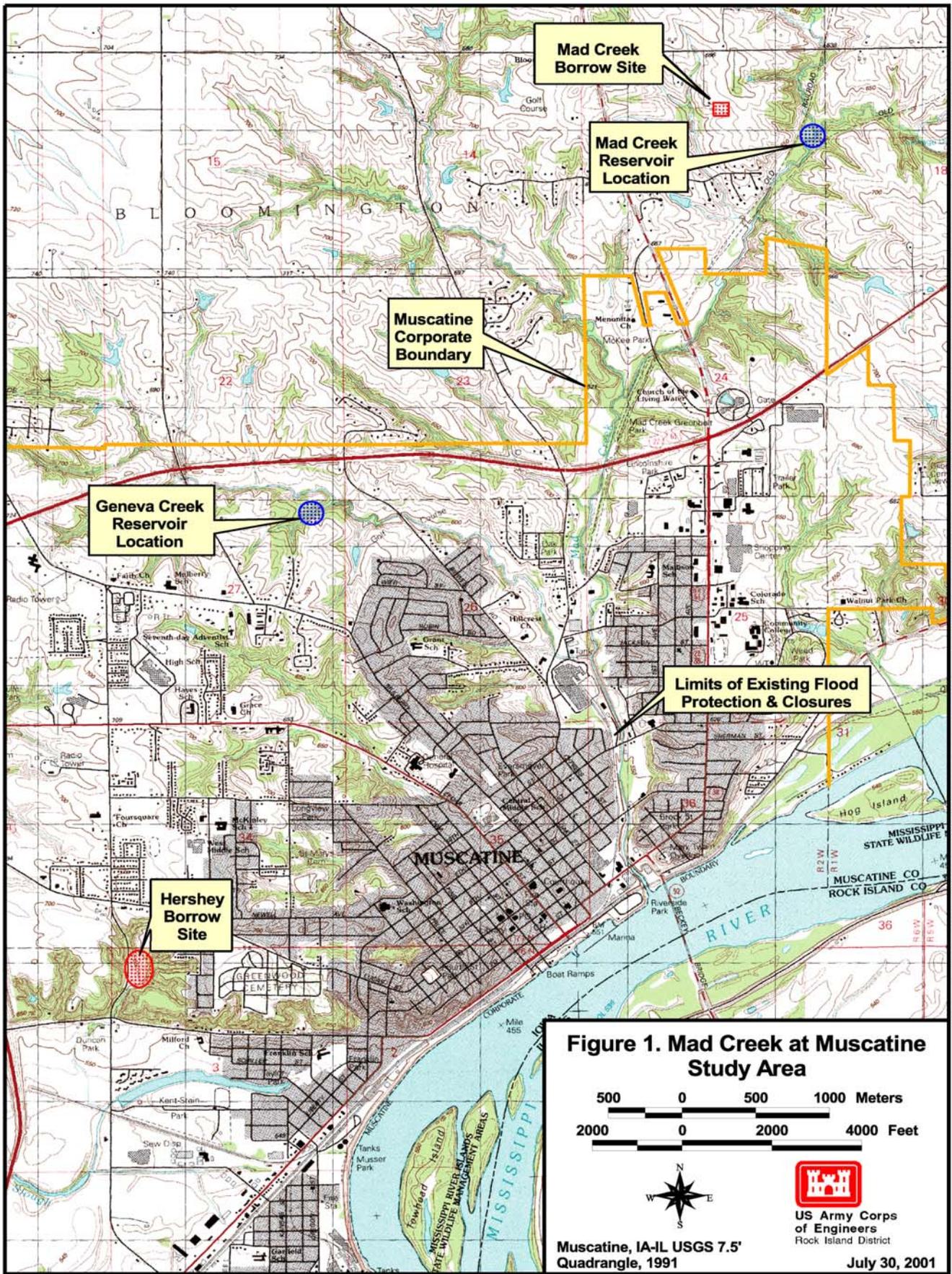


Figure 1. Study area

## 2. PLAN FORMULATION

### a. Assessment of Water and Land Resource Problems and Opportunities.

(1) **Existing Conditions.** The Mad Creek watershed has a total drainage area of 17.3 square miles and enters the Mississippi River near river mile 546. Geneva Creek, a 3.1-square-mile tributary to Mad Creek, flows through parts of the City of Muscatine and enters Mad Creek within the city. Geneva Creek enters Mad Creek in a commercial area of the city, with Mad Creek continuing through additional commercial and residential areas until it enters the Mississippi River.

Two areas adjacent to Mad Creek are protected by previous Federal projects. In 1961, the Rock Island District completed construction of floodwalls and levees along the lower portion of Mad Creek to protect the City from Mississippi River floodwaters backing up the creek. One section of this system is along the Mississippi River (460 feet), while the other continues along the west bank of Mad Creek (3,000 feet). In 1983, the system was extended upstream and upgraded to provide further protection from Mad Creek flooding. This includes a levee and floodwall near the confluence of Geneva Creek with Mad Creek.

The project study area from Geneva Creek to the confluence of Mad Creek with the Mississippi River is composed of mixed commercial, industrial, and residential areas. Low-lying areas are subjected to flash flooding. In addition, increased commercial and industrial development in downtown Muscatine has increased the potential for flood damages since the construction of previous Federal projects. Flooding was experienced in 1990, 1993, 1997, and 2001.

(a) **Creek Study Reaches.** The project study area divided Mad Creek into four separate reaches as depicted on Figure 2 (page 5). Reach 1 includes Mad Creek from its mouth at the Mississippi River to the end of the existing levee (see Figure 3 on page 6). Reach 2 follows the railroad tracks from the end of Reach 1 to a point approximately 200 feet upstream from Washington Street, where the tracks enter the Heinz plant and high ground. Reach 3 follows the existing levee and high ground adjacent to Mad Creek and Geneva Creek to Isett Avenue. Reach 4 includes the existing Mississippi River levee and floodwall from the mouth of Mad Creek southwesterly to Mulberry Avenue (see Figure 4 on page 6).





**Figure 3. Reach 1 - Levee upstream of 5th Street**



**Figure 4. Reach 4 - Floodwall adjacent to the Mississippi River**

**(b) Hydrology and Hydraulics.** The hydrology and hydraulics within the study area are complex in that there are three waterways of concern—the Mississippi River, Mad Creek, and Geneva Creek. Profiles were modeled for flooding occurring on both Mad Creek and the Mississippi River.

Peak discharges are not recorded on Mad Creek, although large floods occurred on both June 30, 1961, and June 16, 1990. The gage on the Mississippi River at Muscatine is located at river mile 453. The 10 highest recorded stages at this gage since 1878 appear in Table 1. A zero gage reading corresponds to an elevation of 530.74 feet MSL (mean sea level), in 1929 datum. The City of Muscatine uses a city datum. Adding 249.1 feet to an elevation in city datum converts it to an elevation in the 1929 datum. All elevations in this report have been converted to the 1929 datum.

**Table 1. Peak stages on the Mississippi River at Muscatine, Iowa (NGVD 1929)**

Rank	Date	Peak Stage (Feet)	Elevation MSL (Feet)
1	07/09/1993	25.61	556.35
2	04/29/1965	24.81	555.55
3	04/25/1973	21.63	552.37
4	04/26/1969	21.20	551.94
5	04/21/1997	21.09	551.83
6	04/28/1952	21.05	551.79
7	04/26/1951	21.00	551.74
8	05/09/1975	20.96	551.70
9	10/07/1986	20.59	551.33
10	04/16/1967	19.40	550.14

Discharge data for the Mississippi River at Muscatine and river stages at the mouth of Mad Creek appear in Table A-4 in Appendix A. These data are from a report prepared by the Corps of Engineers in 1979 for the Technical Flood Plain Management Task Force of the Upper Mississippi River Basin Commission and used for studies on the Mississippi River (listed as Reference 7 on page A-22 in Appendix A). Data in the original report were converted to 1929 datum for this table. Some points were interpolated.

**(c) Previous Hydrologic Studies of Mad Creek by the Corps of Engineers.** Mad Creek has no recording stream gage. The District developed discharge-frequency relationships for Mad Creek using HEC-IFH computer programs.

For this study, the District developed an HEC-HMS model of Mad Creek. This model used two dams that were coordinated with the local sponsor. The loss rates in the HEC-HMS model were verified on a gaged basin, however, insufficient rainfall data prevented calibrating any unit hydrograph parameters. The “without project” discharges from the future condition (year 2020) computed by the HEC-HMS model appear in Table 2. The difference between year 2000 and year 2020 discharges was so small that year 2020 discharges were used for both existing and future conditions. The adopted discharges for the mouth of Mad and Geneva Creeks are provided in Table 3.

**Table 2. “Without” project HEC-HMS discharges used in the Mad Creek Study**

Discharge Probability %	Return Interval Yr.	Mouth of Mad Creek 1960's cfs	Mouth of Mad Creek HMS cfs	U/S Conf. Geneva HMS cfs
50	2	1,400	1,581	1,125
20	5	2,700	3,135	2,296
10	10	4,000	4,252	3,135
4	25	6,100	5,638	
2	50	7,900	7,613	5,480
1	100	10,200	8,733	6,525
0.4	250	14,500	12,093	
0.2	500	17,000	18,327	13,610
Mi <sup>2</sup>		17.3	16.93	13.33

**Table 3. Adopted discharges for Mouth of Mad Creek and Mouth of Geneva Creek**

Probability %	Mad Cr Without Dams Yr. 2020 cfs	Mad Cr With Dams Yr. 2020 cfs	Geneva Cr Without Dams Yr. 2020 cfs	Geneva Cr With Dams Yr. 2020 cfs
50	1,580	1,240	393	286
20	2,880	2,200	797	501
10	3,974	3,000	1,188	640
4	5,636	4,300	1,798	840
2	7,089	5,400	2,356	1,069
1	8,733	6,600	3,010	1,201
0.4	11,240	8,400	4,043	1,700
0.2	13,411	10,000	4,968	2,285

**(d) Human Resources, Development, and Economy.** The City of Muscatine is located on the westerly bank of the Mississippi River in Muscatine County, Iowa. The City has a year 2000 population of 22,697 people according to the U.S. Census Bureau. Major state and Federal highways, railway and waterway systems serve the City of Muscatine. The interstate highway system and major airline transportation systems are also within close proximity. Data indicate that the Muscatine area labor force is concentrated in the manufacturing, retail trade, and service industries. More detailed information can be found in Appendix B - Economic Analysis.

**(e) Floodplain Development.** Based on observations from site visits, reviews of project area maps, and discussions with local citizens, it appears that in several locations over the past 10-20 years, areas within the Mad Creek floodplain and floodway have been filled in (see Figure 5). Many businesses and other facilities are located outside the existing flood protection system and within the area identified as floodplain and/or floodway on the Flood Boundary and Floodway Map, National Flood Insurance Program, dated January 5, 1978. The encroachment of

fill into the channel upstream of 2nd Street and subsequent sediment buildup under the easterly span of the bridge, significantly affected the Mad Creek flood profile.



**Figure 5. Silt buildup under the 2nd Street bridge crossing**

**(f) Cultural Resources.** The Office of the State Archaeologist (OSA) conducted an archeological site file search for the District under Contract DACW25-98-D-0015, Delivery Order No. 3 (Site File Search 134). By a letter dated November 20, 2000, the OSA identified 39 sites within a mile of the project feature locations; however, no sites were recorded within the area of potential effect (APE) of the undertaking. Consultation was initiated with the State Historical Society of Iowa (SHPO), relevant federally recognized tribes, and the interested public regarding the undertaking's potential effects on historic properties and particularly tribal concerns about properties that may be of religious and cultural significance (36 CFR 800.4(a)(3-4)). Responses were received from the SHPO (R&C#: 010170032), the Sac and Fox Nation, and the Iowa Tribe of Oklahoma. No additional historic properties were identified as a result of that consultation.

Subsequent to consultation, project modifications involving floodwall construction necessitated revising the APE to include two historic structures and associated limestone wall. According to *Historic Architecture of Muscatine, Iowa*, as prepared for the city of Muscatine in 1977 by Environmental Planning and Research, Incorporated, the house located at 501 East Mississippi Drive, referred to as the Judge Woodward House, was constructed in 1848 with additions built in 1874. The second house, located next door at 505 East Mississippi Drive, was built around 1846 and is referred to as the Cornelius Cadel House. It is thought that the limestone wall dates to the mid 1870's with the paving of Mississippi Drive and the construction of the Judge Woodward House improvements. A National Register of Historic Places eligibility determination has not been rendered on any of the standing structures, and the lots surrounding these structures have not been

surveyed previously for archeological remains. The revised APE was provided to the SHPO, relevant federally recognized tribes, and the interested public for comment by letter dated April 23, 2002. A draft programmatic agreement (PA) addressing the Corps compliance requirements specific to the revised APE was attached for review and comment. Responses were received from the SHPO (R&C#: 010170032) and the Peoria Tribe of Indians of Oklahoma. The SHPO comments were addressed and the draft PA was provided to the Advisory Council on Historic Preservation (Council) for comment by letter dated June 24, 2002. The Council notified the Corps by letter dated July 12, 2002, that Council participation in the execution of the PA was not required. The final PA was filed with the Council by letter dated November 25, 2002.

**(g) Environmental Setting and Natural Resources.**

Climate. Southeastern Iowa's climate is classified as humid continental and is characterized by cold winters and hot, humid summers. Seasonal contrasts are strong, and the area is subjected to frequent short-term fluctuations in temperature, humidity, cloud cover, and wind direction. Mean monthly temperatures range from 22.3 °F in January to 75.5 °F in July. The average annual temperature is 50.7 °F. The average annual precipitation is 31.88 inches. The mean annual snowfall for the City of Muscatine is 28.5 inches. Additional information regarding climate can be located in Appendix A - Hydrology and Hydraulics.

Air and Noise Quality. The project area is principally located in an industrial area; therefore, existing air and noise quality is fair.

Aquatic Community. Mad Creek drains approximately 17 square acres of land known as the Mad Creek watershed. The existing water quality of Mad Creek is generally poor due to runoff from agricultural fields and the highly industrialized areas surrounding the lower portion of the creek. Mad Creek has a limited fishery with a limited number of species, such as minnows, found in certain portions of the stream.

Terrestrial Habitat and Wildlife. Vegetation located within the existing levee alignment is comprised of mowed grass with limited forbs. The area bordering upper Mad Creek is comprised of typical bottomland forest species and pasture. Terrestrial wildlife is typical of that found elsewhere in the Mississippi River watershed bottomland forests.

Threatened and Endangered Species. No threatened or endangered species would be impacted by the proposed action. For specific information, see *Section VI. Affected Environment*, of the Environmental Assessment (Appendix D).

**(h) Hazardous, Toxic, and Radiological Waste (HTRW) Assessment.** The Corps' Engineering Regulation (ER) providing guidance for the conduct of Civil Works Planning Studies is contained in ER 1105-2-100. The policies and authorities outlined in ER 1165-2-132, Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects, and ER 405-1-12, Real Estate Handbook, were developed to facilitate the early identification and appropriate consideration of HTRW issues in all of the various phases of a water resources study or project. American Society for Testing and Materials (ASTM) Standards E1527-00 and E1528-00 provide a comprehensive guide for conducting Phase I Environmental Site Assessments (ESAs). When the Phase I ESA identifies potential environmental concerns, a Phase II ESA is initiated in which sampling of the project area is performed to determine the presence of any HTRW

contamination. Phase II sampling is completed in accordance with the U.S. Army Corps of Engineers Engineering Manual (EM) 200-1-3, Environmental Quality - Requirements for the Preparation of Sampling and Analysis Plan (CEMP-RT/CECW-E, February 1, 2001). The policy of the U.S. Army Corps of Engineers is to avoid construction of Civil Works projects when HTRW is located within project boundaries or may affect or be affected by such projects.

Several Phase I and Phase II ESAs were performed for this project as the scope was modified. These reports include the following:

- U.S. Army Corps of Engineers, *Mad Creek Flood Damage Reduction Project Hazardous, Toxic, and Radioactive Waste Documentation Report Addendum*, June 2002.
- U.S. Army Corps of Engineers, *Mad Creek Flood Damage Reduction Project Hazardous, Toxic, and Radioactive Waste Documentation Report Addendum*, August 2001.
- U.S. Army Corps of Engineers, *Mad Creek Flood Damage Reduction Project Hazardous, Toxic, and Radioactive Waste Documentation Report*, December 2000.
- Daily & Associates Engineers, Inc., *Preliminary Phase IIA Environmental Site Assessment, Mad Creek Flood Damage Reduction Project*, June 2001.
- Missman Stanley & Associates, P.C., *Preliminary Phase IIA Environmental Site Assessment, Mad Creek Flood Reduction Project, Muscatine, Iowa*, December 2001.

These Phase I and Phase II ESAs covered the following areas:

- Right descending bank of Mad Creek from Isett to the confluence with the Mississippi River;
- Left descending bank of Mad Creek near 2nd Street;
- Right descending bank of the Mississippi River from the confluence with Mad Creek to Mulberry Street;
- Geneva Creek Retention Area;
- Mad Creek Retention Area;
- Mad Creek Borrow Site; and
- Geneva Creek Borrow Site.

On the right descending bank of Mad Creek from 5th Street to the Mississippi River, only the arsenic concentration exceeded the Iowa Land Recycling Plan (LRP) statewide standard. However, the concentrations were below the ingestion and inhalation standards for construction workers under the Illinois TACO standards. This would indicate that short-term exposure during construction of improvements would be well under published guidelines. These contaminants appear to be at or near natural background levels and do not appear to be associated with a specific source of contamination or a spill. No institutional controls are recommended with the conditions as known at the end of the Phase II-A ESA. The results of the sampling indicate that the properties adjacent to the right descending bank of Mad Creek may have contributed some contamination to the existing levee and banks. Contaminants found were at levels below the Iowa LRP statewide. Therefore, contamination by human activities may have occurred, but the contamination is minimal and requires no cleanup action and restricted use of the site.

On the left descending bank of Mad Creek, just upstream of 2nd Street, one Volatile Organic Carbon (VOC) constituent and several polynuclear aromatic hydrocarbon (PNA) constituents were detected on the site. Toluene, the detected VOC constituent, was detected at a concentration less than the statewide standard for soil published by the Iowa DNR. It is recommended that the remediation of toluene is not warranted. One PNA compound was detected at a concentration that

exceeded statewide standards for soil. Under a different laboratory procedure that is more precise, this PNA was less than the statewide standard. For this reason, it is recommended that further assessment or remediation of PNAs is not warranted.

The properties sampled are owned by the city of Muscatine and were owned by the city prior to initiation of this feasibility study. Under Iowa's Voluntary Land Recycling Program, the City of Muscatine may request that the Iowa DNR review the results of the Phase I and Phase II-A ESAs and issue a letter of no further action. The Iowa DNR will determine a background standard for the site pursuant to IAC 567-137.4(455H). They would also identify any special handling requirements, if required, of excavated materials if they are proposed to be removed from the site. Any removal of contaminated material or documentation to the Iowa DNR is beyond the scope of this flood protection project.

Recommendations. The HTRW due diligence process did not reveal any evidence of significant concentrations of hazardous substances, HTRW, or other regulated contaminants in connection with the Mad Creek Flood Damage Reduction Study areas. Therefore, the Mad Creek Flood Damage Reduction Project may proceed without implementing any limitations or special construction techniques commonly associated with HTRW contamination.

Disclaimer. No ESA can wholly eliminate uncertainty regarding the existence for recognized environmental conditions concerning a property. The HTRW due diligence process intends to reduce, but not eliminate, uncertainty regarding the existence of recognized environmental conditions in connection with a property within reasonable limits of time and cost. Continuing the HTRW due diligence process beyond the Phase IIA ESA may not necessarily reduce uncertainty, nor reveal unidentified environmental liabilities. If any previously unaddressed recognized environmental condition should arise, this HTRW due diligence process will be revisited and amended.

(i) Utility Crossings. There are numerous utility crossings along the levee. These utilities should be avoided during construction. If any unusual odor or discolored soil is noted during construction, all activities should cease until the environmental conditions are made known.

(j) Wastewater Treatment. Wastewater treatment lagoons are located adjacent to the proposed Mad Creek Retention Pond. The system serves Ripley's Mobile Homes (also referred to as Clear View Mobile Home Park) located at 30 Clearview Court. If these lagoons are overtopped with floodwater, there could be a release of partially treated wastewater, which, while not an HTRW concern, could be a biological pathogen concern. Impacts on sewage lagoons and future wastewater treatment activities at Ripley's Mobile Homes shall be minimized. If, during the planning process, it is determined that these wastewater facilities will be impacted, appropriate mitigation efforts shall be completed. It was recommended that actions be taken during all planning and implementation phases of the Section 205 project to avoid impacts on the wastewater treatment system at Ripley's Mobile Homes.

(2) Future Conditions without Project Alternatives. As stated previously, low-lying areas in the City of Muscatine are subjected to flooding from Geneva Creek, Mad Creek, and the Mississippi River. Levee closure structures exist on 2nd Street and 5th Street, but the lack of adequate warning time during flash flooding along Mad Creek has made maintaining operation problematic (see Figure 6). Both Isett Avenue and a nearby service entrance that crosses Geneva Creek, have sandbag closures.

The City of Muscatine plans to raise 5th Street starting in 2002. It is assumed that the bridge raise will take place in the future, and the District is providing the City with recommended parameters for the bridge span. With the preferred plan, this area will still flood. The road raise by the City of Muscatine will help traffic flow but may increase upstream water levels. Raising 5th Street in accordance with these parameters will eliminate the need for a closure structure at this location.

Future conditions without the project alternative are anticipated to be status quo, with the continued threat of flooding from Mad Creek, Geneva Creek, and the Mississippi River. Damages will continue to occur in low-lying areas along these waterways.



**Figure 6. 5th Street inundated during spring 2001 flooding**

**b. Specific Problems and Opportunities.** The water resources problem considered in this study is the potential for flash flooding from Mad Creek and Geneva Creek during intense rainfalls. In addition, flood stage elevations on the Mississippi River, which have increased since 1961, were considered in combination with the coincidental flooding of the creeks. Flooding of industrial and commercial properties in the project area has the potential to cause substantial damages to structures, loss of commercial businesses, temporary layoffs, and transportation detours. The City of Muscatine expressed its concern regarding possible damages that a significant flood might cause. The City has demonstrated its commitment to seeking additional flood protection by participating in this study, which it has cost-shared 50/50 with the Federal Government.

**c. Planning Objectives and Constraints.**

(1) **National Objectives.** The national objective of water and related land resources planning is to contribute to economic development consistent with protecting the Nation's environment. Contributions to National Economic Development (NED) are shown as increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct benefits and costs that accrue in the project area and the rest of the Nation.

(2) **Specific Objectives.** Specific planning objectives are derived from an analysis of the problems, needs, and opportunities of the specific study area that can be addressed to enhance the NED objective. The NED plan with the greatest net economic benefits is required to be the plan recommended for Federal action, unless an exception is deemed appropriate. The specific planning objective for this study is to reduce potential economic losses resulting from flooding while giving equal consideration to the environment.

(3) **Planning Objectives.** The following specific planning objectives have been identified based on an analysis of the problems and needs of the Mad Creek study area:

- Provide a flood damage reduction project within the study area that satisfies Corps of Engineers' criteria for net benefits.
- Preserve and enhance, when practicable, existing natural ecological systems and cultural resources in the area.
- Recreation in the form of a multipurpose trail on the top of the upgraded levee adjacent to Mad Creek was considered as a possible project feature but not pursued due to some constraints in the study area and an undefined path alignment.

(4) **Planning Constraints.** The authority under Section 205 provides for the construction of projects for flood control and related purposes. Each project is limited to a Federal investment of not more than \$7 million. This Federal investment limitation includes all project-related costs for investigations, inspections, engineering, preparation of plans and specifications, supervision and administration, and construction.

Water resources planning studies are bound by all applicable laws of the United States and of the State of Iowa, all Executive Orders of the President, the Water Resources Council's Principles and Guidelines, and all engineering regulations of the U.S. Army Corps of Engineers.

#### **d. Development of Alternative Plans.**

(1) **Available Measures to Address Problems and Opportunities.** Both nonstructural and structural measures are available to alleviate flooding.

(a) **Nonstructural Measures.** These measures are defined as those which reduce or eliminate flood damages, without significantly altering the nature or extent of flooding, by changing the use of floodplains or accommodating existing uses into the flood hazard. Examples of nonstructural measures are flood proofing, permanent evacuation, flood warning systems, and regulation of the use of the floodplains.

**(b) Structural Measures.** These measures are designed to prevent flood damages by altering the physical ability of flooding to produce the damages. Structural measures may include dams, channel modifications, levees, and floodwalls.

During the initial assessment and development of a Project Study Plan (PSP) for the feasibility study, several measures were considered. It was determined that structural measures (levee and floodwall raises) were likely to be technically feasible. The following measures were evaluated in the feasibility study:

- Raising the existing floodwall and levee system
- Constructing stormwater detention dams
- Enhanced early flood warning system
- Improved closure structures
- Existing channel improvements

**(2) Screening of Alternative Plans.** Alternatives considered in the feasibility study included the following:

**(a) No Federal Action.** Under the No Federal Action alternative, the Corps will not participate in efforts to provide additional flood protection to the study area. The no action plan is the “without project” alternative that serves as the basis for developing and comparing the impacts of other plans. It is assumed that under the no action plan, no project would be implemented to reduce flood damages and therefore the study area would continue to experience flood damages.

**(b) Nonstructural.** Some nonstructural measures are implementable for the Mad Creek study area in combination with the structural measures already in place. Regulation of floodplain use with or without a levee raise is recommended and complies with the non-Federal responsibilities outlined in Section 4 of this report. An improved flood warning system was developed for the study area and is described in detail in Appendix A - Hydrology and Hydraulics.

**(c) Structural.** The following structural alternatives were evaluated in detail during the feasibility study. A flood warning system may be combined with any of the alternatives.

Alternative A - Raise the existing levee/floodwall system adjacent to Mad Creek and install a positive closure structure on Geneva Creek.

Reach	Measure	Description
1	Raise Levee/Floodwall	Raise the existing levee/floodwall adjacent to Mad Creek 1, 2, or 3 feet. Install an improved closure structure at 2nd Street.
2	Railroad Raise	Raise railroad embankment 1 foot.
3	Closure Structures (Geneva Creek)	Install positive closure structures at Isett Avenue and the Heinz Service road.

Alternative B - Construct two storm water detention dams along Mad and Geneva Creeks.

Reach	Measure	Description
1,2,3	Mad Creek Dam	Construct 1% event dam on Mad Creek.
1,2,3	Geneva Creek Dam	Construct 1% event dam on Geneva Creek immediately downstream of the Highway 61 bypass.

Alternative C - This alternative is a combination of Alternative A (levee raise) and Alternative B (detention dams).

Reach	Measure	Description
1	Raise Levee/Floodwall	Raise the existing levee/floodwall adjacent to Mad Creek 1, 2, or 3 feet. Install an improved closure structure at 2nd Street.
2	Railroad Raise	Raise railroad embankment 1 foot.
3	Closure Structures (Geneva Creek)	Install positive closure structures at Isett Avenue and Heinz service road.
1,2,3	Mad Creek Dam	Construct 1% event dam on Mad Creek.
1,2,3	Geneva Creek Dam	Construct 1% event dam on Geneva Creek immediately downstream of the Highway 61 bypass.

Alternative D - Raise the existing levee and floodwall system (1, 2, or 3 feet) along Mad Creek and the Mississippi River in combination with channel improvements upstream of the 2nd Street Bridge.

Reach	Measure	Description
1	Raise Levee/Floodwall	Raise the existing levee/floodwall adjacent to Mad Creek 1, 2, or 3 feet. Install an improved closure structure at 2nd Street.
4	Raise Levee/Floodwall	Raise the existing levee/floodwall adjacent to the Mississippi River 1, 2, or 3 feet.
1	Channel Improvement	Clean out 2nd Street Bridge and improve Mad Creek channel upstream of the bridge.

**(3) Plan Evaluation.** The study alternatives in this report were evaluated for their ability to meet the project objective of reducing flood damages and also from an economic standpoint. The National Economic Development (NED) plan is defined as the plan with the greatest net economic benefit while being consistent with protecting the Nation’s environment, and thus contributes the most to national economic development. A detailed discussion of the economic evaluation of the project alternatives is found in Appendix B - Economic Analysis.

Table 4 summarizes the planning, administration, and real estate costs associated with each plan alternative, thereby giving a total plan cost including construction. Construction costs for the different alternatives as represented in Appendix G - Cost Estimates - Alternatives and Selected Plan, are used to establish planning and administration cost estimates. Real estate costs are then figured by the alternative’s land needs and subsequent administration, thereby giving a total plan cost. The selected plan (Alternative D-2) has a total plan cost of \$3,445,000.

**Table 4. Plan costs including planning, administration, and real estate**

Plan Alternatives	Construction Cost including Line Item Contingencies	* Planning, Engineering and Design (20%)	Supervision and Administration (9%)	Lands, Easements, Right-of-way, Relocations, Dredge Disposal	Federal Real Estate Administration	Total Plan Costs
A-1a Mad Creek 1 ft Levee Raise - Reach 1	\$1,072,000	\$214,000	\$96,000	\$367,000	\$26,000	\$1,775,000
A-1b Mad Creek 2 ft Levee Raise - Reach 1	\$1,314,000	\$263,000	\$118,000	\$367,000	\$26,000	\$2,088,000
A-1c Mad Creek 3 ft Levee Raise - Reach 1	\$1,879,000	\$376,000	\$169,000	\$367,000	\$26,000	\$2,817,000
A-2 Mad Creek Railroad Raise - Reach 2	\$828,000	\$166,000	\$75,000	\$130,000	\$8,000	\$1,207,000
A-3 Geneva Creek Closures - Reach 3	\$531,000	\$106,000	\$48,000	\$31,000	\$5,000	\$721,000
B Reservoirs, Mad & Geneva Creek	\$4,006,000	\$801,000	\$361,000	\$2,765,000	\$109,000	\$8,042,000
C-1 Reservoirs and 1 ft Levee Raise - Reach 1	\$4,920,000	\$984,000	\$443,000	\$3,168,000	\$140,000	\$9,655,000
C-2 Reservoirs and 1 ft Levee Raise - Reach 2	\$4,670,000	\$934,000	\$420,000	\$2,895,000	\$117,000	\$9,036,000
C-3 Reservoirs and Reach 3 Closures	\$4,373,000	\$875,000	\$394,000	\$2,796,000	\$114,000	\$8,552,000
D-1 Mad Creek Channel Improvements & 1 ft Levee Raise - Reaches 1&4	\$1,994,000	\$484,000	\$179,000	\$505,000	\$93,000	\$3,255,000
<b>D-2 Mad Creek Channel Improvements &amp; 2 ft Levee Raise - Reaches 1&amp;4</b>	<b>\$2,141,000</b>	<b>\$513,000</b>	<b>\$193,000</b>	<b>\$505,000</b>	<b>\$93,000</b>	<b>\$3,445,000</b>
D-3 Mad Creek Channel Improvements & 3 ft Levee Raise - Reaches 1&4	\$2,759,000	\$637,000	\$248,000	\$505,000	\$93,000	\$4,242,000

\* Planning, Engineering and Design includes \$85k for cultural mitigation on alternatives D-1, D-2 and D-3 is above and beyond the 20% rate indicated.

Table 5 summarizes the costs and benefits of each alternative. The net benefit is the difference between the average annual economic benefit and the average annual cost of a plan. Alternative A-1's different levee elevations are all economically justified, having annual benefits exceeding annual costs. However, Alternative D-2, which includes a 2-foot levee raise, has the greatest net benefits and is therefore the selected NED plan.

**Table 5. Costs and benefits by alternative**  
(June 2002 prices, 6-1/8% discount rate, 50-year evaluation period)

Alternative	Project Costs, \$	Total Annual Costs, \$	Total Annual Benefits, \$	Net Benefits, \$	Benefit-Cost Ratio
<b>No Action</b>	0	0	0	0	0
<b>A-1. Mad Creek Levee Raise - Reach 1</b>					
a. 1-foot raise	1,775,000	121,764	121,200	-564	0.995
b. 2-foot raise	2,088,000	143,236	265,200	121,964	1.85
c. 3-foot raise	2,817,000	193,245	397,400	204,155	2.06
<b>A-2. Railroad Raise, 1 foot (Reach 2)</b>	1,207,000	80,303	300	-80,003	0.00
<b>A-3. Geneva Creek Closures (Reach 3)</b>	721,000	47,969	11,100	-36,869	0.23
<b>B. Mad &amp; Geneva Creek Dams (.01)</b>	8,042,000	584,670	456,100	-128,570	0.78
<b>C. Dams (.01) and 1-foot Levee Raise</b>					
<b>C-1. Dams and Reach 1 raise (1 foot)</b>	9,655,000	698,796	500,500	-198,296	0.72
<b>C-2. Dams and Reach 2 raise (1 foot)</b>	9,036,000	654,999	456,300	-198,699	0.70
<b>C-3. Dams and Reach 3 Closures</b>	8,552,000	620,754	456,300	-164,654	0.73
<b>D. Raise Mad Creek/Mississippi Levee/Floodwall and Improve Mad Creek Channel</b>					
<b>D-1. 1-foot raise (Reaches 1 and 4)</b>	3,255,000	227,362	691,600	464,238	3.04
<b>D-2. 2-foot raise (Reaches 1 and 4)</b>	3,445,000	240,426	823,000	582,574	3.42
<b>D-3. 3-foot raise (Reaches 1 and 4)</b>	4,242,000	295,150	828,500	533,350	2.81

(4) **Associated Evaluation Criteria.** Alternative plans were also evaluated by the following criteria:

- Completeness - Completeness is the extent to which a given alternative plan provides and accounts for all the necessary investments or other actions, to ensure the realization of the planned effects. Each of the plans evaluated are complete.
- Effectiveness - Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the recognized opportunities. The planning objective of this study was to reduce flood damages within the project area. With the exception of the “without project” alternative, each of the other alternatives reduces flood damages to some degree. Alternative D-2 provides the highest net benefit.
- Efficiency - Efficiency is the extent to which an alternative plan is considered a cost-effective means of solving the specified problems and of realizing the recognized opportunities. Alternative D-2 yields the greatest net benefits and is therefore the most cost-effective plan from an NED perspective.
- Acceptability - Acceptability is the viability of an alternative plan with respect to the desires of the state, local government, and the public. In order to be acceptable, the

plan must be in accordance with existing laws, regulations and public policies. All alternatives evaluated were considered acceptable.

(5) **Risk-Based Analysis.** Evaluation of the existing condition and proposed alternatives was conducted using a risk-based analytical framework as described in Engineering Manual 1110-2-1619, *Risk-Based Analysis for Flood Damage Reduction Studies*. The analysis is described in detail in Appendix A - Hydrology and Hydraulics and Appendix B - Economic Analysis.

(6) **Residual Risks of Selected Plan.** With memories of recent floods still fresh, risks of catastrophic events need to be visited. For any level of flood protection provided, there is a risk of an event that would overtop or breach the protection system. The probability of exceedance (flood protection system is overtopped) in any given year is very low with the recommended plan to increase the top of the existing levee (see Table 6). However, the results of an overtopping event would be disastrous (see Appendix B, Table B-5), given the huge value and diversity of the properties protected by the levee. It is important that parties concerned realize the risks and potential consequences of a structural flood damage reduction project.

### 3. DESCRIPTION OF THE SELECTED PLAN

**a. Plan Components.** Major components include raising the height of approximately 2,300 linear feet of existing levees and 1,700 linear feet of existing floodwalls by approximately 2 feet, constructing 230 linear feet of new floodwall, replacing the existing panel closure at Mississippi Drive with a new bulkhead closure gate, replacing an existing floodgate at 2nd Street with a new overhead closure gate (see Figure 7), replacing the panel closure across the abandoned railroad just upstream on 2nd Street with a new swing gate, and installing a new closure structure across the railroad south of Washington Street. Minor modifications to the existing pump houses and gatewells along the Mississippi River and Mad Creek may be required due to the increase in flood protection height. The selected plan also includes improving a section of the Mad Creek channel upstream of 2nd Street to reduce flood stages and installing an enhanced flood warning system. In a separate but supporting effort, the City of Muscatine would raise the roadway and bridge at the 5th Street crossing of Mad Creek. This would allow the removal of the existing floodgate at 5th Street, thereby eliminating a high-risk closure.

The selected plan (project) would follow the alignment of the existing flood protection system. Plate X103 in Appendix L shows the general flood damage reduction plan. Plates C102 through C105 show plans and profiles, plate C106 shows typical levee and floodwall sections, and plate C101 shows boring logs.

Additional benefit protection provided by the selected plan would accrue to small businesses and industry in the downtown area.

Minor modifications to the existing pumphouses along the Mississippi River may be required due to the increase in flood protection height. Additionally, three gatewells along Mad Creek may require increases in height due to the levee raise (see plate S501, Appendix L).

The selected plan (project) alignment D-2 would provide protection to elevation 561.5 feet NGVD. Elevation 561.5 feet would remain constant along the designated Mississippi River reach and the reach from the mouth of Mad Creek up to its termination point north of 5th Street due to the backwater effect of the Mississippi River.

The selected plan begins with a temporary earthen levee approximately 270 feet in length located halfway up the block from Mississippi Drive on Mulberry Avenue. The temporary levee would only be constructed for flood events that are projected to exceed 555.0 feet NGVD and built to a top elevation 561.5 feet NGVD. The temporary earthen levee would extend to a new floodwall that starts about mid block on the eastern side of Mulberry Avenue.

The new floodwall would replace an existing retaining wall that runs along two historic properties at the corner of Mulberry Avenue and Mississippi Drive (see plates C102 and C106). The floodwall would extend south down Mulberry Avenue to Mississippi Drive where it would turn east until it ties into the existing flood control system. The existing panel closure across Mississippi Drive would be removed and replaced with a new bulkhead gate closure (see plates C102, S301, and S302). The project would continue easterly following the existing floodwall along the Mississippi River to where it ties into an existing section of levee. The floodwall, approximately 840 feet long, would be raised 2 feet to bring it up to the 561.5 feet NGVD elevation (see plates C102 and C106).

The floodwall along the Mississippi River transitions into a levee section approximately 400 feet west of the mouth of Mad Creek. This levee section follows Mad Creek by turning north, where it transitions into a floodwall section at 2nd Street. This levee, approximately 600 feet long (total), would be raised to match the adjoining floodwall elevation, while staying within the existing levee footprint. The current levee side slope is 3 horizontal to 1 vertical (3H:1V) with an 8-foot top width. This existing impervious clay levee would be raised in height by steepening the side slopes. Final side slopes would be approximately 2.5 horizontal to 1 vertical (2.5H:1V). Although a 3 to 1 slope is preferred for a levee of this nature, a 2.5 to 1 slope is acceptable, and due to the limited site clearances, the 8-foot-wide top would be maintained.

The existing floodwalls adjacent to 2nd Street, both upstream and downstream, would be modified in similar fashion as those found along the Mississippi River. The existing floodgate at 2nd Street (Figure 7) would be removed and replaced with a vertical lift gate to facilitate quicker and more reliable closure under flash flood conditions, as is frequently experienced along Mad Creek. Vertical lift gates have been successfully installed in the Des Moines, Iowa, metro area on similar flash flood streams (see plate S101). In addition, the abandoned railroad and associated panel closure would be eliminated and replaced with a new swing gate closure to facilitate future trail plans through this opening (see plate S101).



**Figure 7. Existing panel closure structure at 2nd Street**

Silt buildup beneath the 2nd Street Bridge on the left descending bank has severely reduced the capacity of the bridge to pass design flows, thereby causing higher water levels during Mad Creek flooding events. This restriction would be removed as a part of the project, with continuing maintenance procedures established to ensure that any recurrence is addressed similarly (see plate C107).

The levee section between 2nd and 5th Streets would be raised to the design elevation to match the levee section found at the mouth of Mad Creek. The footprint would remain the same, thereby requiring the steeper side slope of approximately 2.5 horizontal to 1 vertical (2.5H:1V) as along the Mississippi River.

The existing floodwalls adjacent to 5th Street would be modified similar to those found along the Mississippi River. The floodgate at 5th Street would be removed and would not be replaced. The City of Muscatine is nearing a contract award to build a new 5th Street Bridge designed high enough to eliminate the need for a closure at this location. The new 5th Street Bridge is scheduled to be completed prior to the start of the selected plan outlined in this report. However, should the 5<sup>th</sup> Street Bridge project not be completed prior to the completion of the selected plan as outlined in this report, the City of Muscatine will be required to provide a temporary or permanent closure at this location that provides protection up to elevation 561.5 feet NGVD.

The levee section north of 5th Street would be raised to the design elevation to match the levee section found at the mouth of Mad Creek. The footprint would remain the same, thereby requiring the steeper side slope of approximately 2.5 horizontal to 1 vertical (2.5H:1V) as along the Mississippi River. This existing section of levee was previously constructed under two different contracts and to different design heights. The southern section of the existing levee would require more fill as it is approximately 1.5 feet lower than the more recent northern levee.

An earlier Mad Creek flood protection project included the raising of the railroad and roadway at the intersection of Mad Creek with Washington Street. Consideration was given to accomplishing an additional raise in order to provide passive closure at this location; however, it was determined that it would be impractical to raise the railroad an additional 2 feet. Therefore, it is recommended that a railroad closure be constructed at the termination point of the existing levee (see plates S201, S202, and S203).

Protection of the low-lying areas west of Mad Creek along Washington Avenue was not determined to be economically feasible; therefore, no work would be accomplished in this area.

High ground east of the Heinz plant provides natural protection to that stretch of Mad Creek from the southeast corner of the plant to a point west of the confluence of Mad Creek and Geneva Creek. A previous contract provided flood protection along the southerly descending bank of Geneva Creek north of the Heinz plant. This levee system provides adequate protection and would not be modified. Analyses of the openings at Isett Avenue and the bridge access to the Heinz plant revealed that no improvement to the current sandbag closure methodology is economically justified.

**b. Design and Construction Considerations.** Plans and specifications will be completed after completion of the feasibility study. A Design Documentation Report (DDR) will be completed during the plans and specifications phase.

(1) **Design Considerations.** Due to the need to raise the existing floodwall approximately 2 feet, an overturning analysis was performed to confirm the floodwall's stability caused by the additional loading. Sufficient capacity exists to resist this overturning. Confirmation of the wall's internal structural strengths and sizing of the wall extension reinforcing was checked and determined to be not adequate to support the additional loads resulting from a 2-foot raise. The existing floodwall will need to be strengthened with buttresses for earth berms on the landside of the floodwall.

Landscaping needs for the project would be minimal due to the nature of the project; however, coordination for the required landscaping may be needed to make allowances for the future recreational trail that the City of Muscatine is proposing along Mad Creek.

(2) **Utilities.** The initial construction of the levee and floodwall system during the 1970's and 1980's required the relocation of numerous utilities and structures. The criteria for current modifications show that the proposed improvements of the selected plan (project) are located within the existing levee footprint. This requirement results in minimal disruption to existing utilities and structures.

Modifications to the existing pumphouses may be required to allow for the raise in protection. It is anticipated that the three gatewells located along Mad Creek from its mouth to 5th Street would require height adjustment to match the new protection level.

(3) **Construction Considerations.** Special coordination would be required during modification of the levee and floodwalls, especially near HON Industries, in order to minimize impact to their manufacturing processes.

Additional coordination would be required for construction of the closure structure at the railroad tracks as it affects rail access into the Heinz plant. This would require close coordination with the railroad company.

(4) **Value Engineering.** Value Engineering (VE) is an organized, systematic effort to reduce project costs without sacrificing quality, function, reliability or operation and maintenance requirements. A VE study has been completed on the recommended plan. The VE study recommends several proposals for further consideration during the plans and specifications stage of the project. The proposals include: reducing the length of the 2nd Street vertical lift gate by 20 feet, using a double leaf swinging miter gate instead of the vertical lift gate at 2nd Street, using pre-cast concrete panels doweled to the existing floodwall to raise it 2 feet instead of cast-in-place concrete, using a concrete walkway and parapet wall on top of the existing levee to raise it 2 feet instead of raising the levee with clay fill, and finally eliminating gateway modifications.

c. **Operation and Maintenance Considerations.** The City of Muscatine would perform regular operation and maintenance practices after project construction. Some of the items to be addressed would include: levee gate closure during flood events, silt deposit removal from the channel of Mad Creek, placement of sandbags at the Heinz access bridge and the Isett closure, and maintenance of the flood warning system.

Levee maintenance would involve mowing the grass cover, removing brushy growth, controlling burrowing animals, and repairing the damage they may have caused to the levee. Mowing of the new 2.5H:1V levee side slopes would likely require special equipment. The City indicates they

have the capability to mow this steep of a slope. These maintenance tasks are required to preserve the integrity of the levee and to allow for periodic inspections.

The flood warning system for the Mad Creek and Geneva Creek basins would be used in conjunction with the NED Plan to provide additional response time for required operation of the levee system closures. The flood warning plan would be finalized during the construction plans and specifications phase. See pages A-18 thru A-21 of Appendix A for operation and details of the flood warning system.

The flood damage reduction project along Mad Creek includes channel modifications at and upstream of the 2nd Street Bridge to improve the hydraulic capacity of the bridge and channel through this reach. These channel improvements would result in a decrease in flood profile heights. The City of Muscatine must maintain the improved channel to at or near as-built design condition in order for the project to function as intended. The channel improvements are shown on plate C107. Periodic mowing of the improved channel reaches to inhibit brush and tree growth must be performed on an as-needed basis (1-2 times per year). Such maintenance would enhance the life of the channel/bridge improvements. Cleanout maintenance would occur when sediment deposits in the improved channel accumulate to a depth of 2 feet or more above the restored as-built channel dimensions. To facilitate the noting of silt deposition depths, paint markings on the 2nd Street Bridge pier and abutments should be placed to provide a field visual aid in recognizing when maintenance activities are required. Failure to maintain the channel improvements would result in increases in the design flood profiles, resulting in possible overtopping of the flood protection system. It is estimated that channel cleanout may be required every 2 years.

Operation and maintenance costs were not factored into the economic analysis for the selected plan or any of the alternatives. The alternatives involving detention dams (reservoirs) have very low benefit-cost ratios, so insignificant operation and maintenance costs would not change their status. The remaining alternatives are almost identical in the operation and maintenance associated with them, so operation and maintenance costs were not considered as a factor for determining the selected plan.

**d. Plan (Project) Cost Estimate.** The selected plan, D-2 Mad Creek Channel Improvements and 2-Foot Levee Raise - Reaches 1 & 4, has a March 2002 MCACES estimated total project cost of \$3,445,000 (see Table 6). The fully funded estimate for the selected plan, MCACES summary estimates for all alternatives, and a detailed MCACES estimate of the selected plan can be found in Appendix G - Cost Estimates - Alternatives and Selected Plan.

**Table 6. Project cost distribution  
Plan D-2, channel improvements with 2-foot levee raise  
Muscatine, Iowa**

<u>Total Project Cost Estimate</u>	\$3,445,000
<u>Federal Cost Estimate</u>	2,239,250
<u>Non-Federal Cost Estimate</u>	1,205,750
Lands, Damages, & Relocations	\$505,000
Cash Contributions	\$700,750
Non-Federal Share Percent of Total Cost:	35%

e. **Plan Accomplishments.** Construction of a levee/floodwall system would substantially reduce damages due to flooding from both Mad Creek and the Mississippi River. The City seeks flood protection for its central business district and its two largest employers. Table 7 shows that the selected plan would provide the following levels of protection for the proposed improvements on Reaches 1 and 4.

**Table 7. HEC-FDA performance statistics for proposed plan**

Reach	Term Risk			Conditional Non-Exceedance Probability by Events						Crest Feet
	Long 10-yr	25-yr	50-yr	10%	4%	2%	1%	.4%	.2%	
1	.019	.05	.09	1.00	1.00	1.00	1.00	.99	.99	561.4
4	.0028	.0071	.014	1.000	1.000	1.000	0.9996	0.996	0.993	561.5

The long-term risk gives the probability of the levee being exceeded during a 10-, 25-, or 50-year period. The conditional non-exceedance probability looks at performance by event. It gives the chance of the levee containing (not being overtopped by) the specified exceedance probability.

f. **Economic Effects.** The NED Plan will reduce annual flood damages by \$823,000 while requiring an annualized cost of \$240,426 for a benefit-to-cost ratio of 3.4. This results in a net benefit (annual benefit minus annual cost) of \$582,574. A detailed economic analysis is provided in Appendix B.

g. **Social Effects.**

(1) **Community and Regional Growth.** No adverse impacts to the growth of the community or region would be realized as a direct result of the selected plan (project).

(2) **Community Cohesion.** The project would be expected to somewhat enhance community cohesion by reducing further damages from flooding and securing the economic viability of businesses located in the floodplain/floodway.

The lower portion of Mad Creek is located within the Muscatine city limits, flowing through an area of mixed commercial, industrial, and residential uses near the downtown area before emptying into the Mississippi River. The city administration and area property owners have expressed support for the project. Coordination with Federal and state agencies has not revealed any objections or concerns.

(3) **Displacement of People.** The project involves raising the existing flood control levee and floodwall, plus some channel improvements. No residential displacements would occur as a result of the project.

(4) **Property Values and Tax Revenues.** The potential value of property in the project vicinity could increase as a result of the project construction.

(5) **Public Facilities and Services.** The project involves upgrading the existing levee and floodwall system, thus improving public facilities while other public facilities and infrastructure located within the protected area would benefit from reduced flood damages following project construction.

A public marina, boat ramp, and city park are located on the Mississippi River adjacent to the existing floodwall. The project would not adversely affect access to, or use of, these public facilities.

(6) **Business and Industrial Activity.** The project would positively impact existing business and industrial activity by further reducing the threat of flooding. Significant commercial/industrial expansion in the project area is not expected due to the current density of use. No business relocations would be required due to the project.

(7) **Employment and Labor Force.** The project would temporarily increase area employment during the 2-year construction phase. There would be no significant long-term effect on employment or labor force within the City of Muscatine or Muscatine County.

(8) **Farm Displacement.** The project is located in an urban area; thus, no farms would be affected.

(9) **Life, Health and Safety.** Upgrading the existing flood protection system would further reduce life, health, and safety concerns faced by area residents and business owners.

(10) **Noise Levels.** The project would temporarily increase noise levels over the 2-year construction period. The project area is primarily developed for industrial uses and no significant or long-term noise impacts to residents or sensitive receptors are expected.

(11) **Aesthetics.** The project would raise the existing levee and floodwall and clean out a portion of the existing channel. The appearance of the finished project would not be much different than what is already in place; therefore, no significant change to the aesthetic resources of the area is expected.

**h. Environmental Effects.**

(1) **Natural.** The existing land use in the study area is predominantly urban with some agricultural usage. The agricultural land provides food and shelter for wildlife, while the developed areas provide habitat for small mammals and birds.

The majority of the project area is contained within the urban and heavily developed city limits of Muscatine. The proposed levee and floodwall alternatives are generally confined to a within levee cross-section upgrade, thus minimizing the overall impacts to the surrounding environment. However, the proposed detention basins would likely impact existing wetlands and pasture.

The proposed channel improvements would improve hydraulics in the area around the 2nd Street Bridge, thus reducing the occurrence of flooding within the City. Following vegetation removal and excavation of the filled in area, the bankline would be graded and reseeded with native wetland vegetation (see Figure 8).

The U.S. Fish and Wildlife Service’s Fish and Wildlife Coordination Act Report (FWCAR) states that there are federally listed endangered or threatened species in Muscatine County, although none would be adversely impacted as a result of the selected plan (project). The FWCAR, along with a more detailed description of existing environmental conditions, can be found in Appendix D - Environmental Assessment.

The industrialized and residential areas within the Mad Creek levee district will be positively affected by reduced flooding impacts as a result of upgrading the levee system.

**Mad Creek Channel Improvement  
Wetland Area**



**Figure 8. Channel excavation of fill at 2nd Street Bridge**

**(2) Cultural.** Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations 36 CFR Part 800 require Federal agencies to take into account the effect of an undertaking on significant historic properties if that project is under the direct or indirect jurisdiction of the agency or has been licensed or assisted by that agency. The District determined that the proposed undertaking had potential to cause effects to significant historic properties (36 CFR 800.3(a)) and provided that determination along with proposed research measures to the SHPO, relevant federally recognized tribes, and the interested public for review and comment. The SHPO concurred with the District's determination by letter dated January 29, 2001 (R&C#: 010170032) and both the Sac and Fox Nation and the Iowa Tribe of Oklahoma indicated interest in the undertaking and the results of the archeological investigation.

The District contracted for an archeological survey with Bear Creek Archeology (BCA) of Cresco, Iowa, under Contract DACW25-98-D-0001, Delivery Order 25. The investigation evaluated the potential borrow areas and resulted in the documentation of four newly recorded prehistoric archeological sites. Based on recommendations presented in the BCA report, the District determined that these historic properties were not eligible for listing on the National Register for Historic Places and that further archeological investigation was not warranted. The BCA report and District determination were provided to the SHPO for review and comment. The SHPO concurred with the District's determination by letter dated June 11, 2001, with the exception that the SHPO recommended archeological survey of the potential retention basin sites. The retention basin project features, however, are not part of the preferred alternative and therefore are not part of the area of potential effect of this undertaking.

Subsequent to consultation, project modifications involving floodwall construction necessitated revising the APE to include two historic structures and associated limestone wall. A National Register of Historic Places eligibility determination has not been rendered on any of the standing structures, and the lots surrounding these structures have not been surveyed previously for archeological remains. The District and the Iowa SHPO have signed a PA (Programmatic Agreement) (Appendix I) regarding implementation of the project and the revised area of potential effect (APE). This PA is an appropriate vehicle for addressing historic property concerns for this undertaking at the historic wall and historic structure locations within the revised APE.

While the District is assured that no significant historic properties would be affected by the preferred alternative, if any undocumented historic properties are identified or encountered during the undertaking, the Corps would discontinue project activities and resume coordination with the consulting parties to identify the significance of the historic property and determine any potential effects.

**(3) Hazardous, Toxic, and Radiological Waste (HTRW) Assessment.** Based on the findings of the Preliminary Phase II-A Environmental Site Assessment, the Mad Creek Flood Damage Reduction Project may proceed without limitations or special construction techniques, which are associated with HTRW contamination. The HTRW Documentation Report is on file at the Rock Island District office.

#### 4. PLAN IMPLEMENTATION

**a. Implementation Requirements.** To implement the selected plan (project), a number of steps would be required, starting with report approval through operation and maintenance by the project sponsor. The following milestone schedule depicts the necessary steps.

##### **Project Completion Schedule**

<b>Task</b>	<b>Duration</b>
Execute Project Cooperation Agreement	8 weeks*
Complete plans and specifications	48 weeks
Right-of-way acquisition by sponsor	48 weeks
Award construction contract	9 weeks
Complete construction	102 weeks

\* Following approval of the DPR and commitment of funds

#### **b. Implementation Responsibilities.**

**(1) Federal Responsibilities.** The preparation of plans and specifications for construction will be financed up front 100 percent by the Federal Government, following approval and receipt of funds, with the local cost-sharing portion repaid beginning with the first fiscal year of construction. Project construction will be cost-shared 65 percent Federal/35 percent local. The Federal share is estimated to be \$2,239,250. The Corps of Engineers will supervise and administer the construction contracts in accordance with the Project Cooperation Agreement and available funding.

**(2) Non-Federal Responsibilities.** The Project Cooperation Agreement (PCA) is the formal assurance between the Federal and non-Federal partners. Within the PCA, the sponsor must agree to:

- Provide, without cost to the Government, during the period of construction, all lands, easements, rights-of-way, and utility and facility alterations and relocations required for construction and maintenance of the project, regardless of their value.
- Make a cash payment of not less than 5 percent of the total project costs during the period of construction, regardless of the value of the items listed above. If the value of the items listed above is less than 30 percent of total project costs, the sponsor shall, during the period of construction, make such additional cash payments as are necessary to bring its total contribution in cash and value of lands, easements, rights-of-way, and utility and facility alterations and relocation, to an amount equal to 35 percent of the total project costs.
- Contribute all project costs in excess of the Federal statutory limitation of \$7,000,000.
- Hold and save the Government free from all damages arising from the construction, operation, maintenance, and rehabilitation of the completed project, except for damages due to the fault or negligence of the Government or its contractors.

- Operate, maintain and rehabilitate the project upon completion in accordance with regulations or directions prescribed by the Secretary of the Army.
- Accomplish, without cost to the United States, all alterations and relocations of buildings, transportation facilities, storm drains, utilities, and other structures and improvements made necessary by construction of the project.
- Prevent encroachment on any of the flood protection structures, including ponding areas, and if ponding areas are impaired, provide substitute storage capacity or equivalent pump capacity promptly without cost to the United States.
- Prescribe and enforce regulations to prevent obstruction or encroachment on channels which will reduce their flood-carrying capacity or hinder maintenance and operation.
- Participate in and comply with applicable Federal floodplain management and flood insurance programs. Publicize floodplain information in the areas concerned and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to ensure compatibility between future development and protection levels, including ponding areas, provided by the project.
- Annually inform residents of the potential flood risks.
- Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, approved January 2, 1971, in acquiring lands, easements, and rights-of-way for construction and subsequent operation and maintenance of the project and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.
- Comply with Section 601 of Title VI of the Civil Rights Act of 1964 (Public Law 88-352) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations, in connection with the construction, operation, and maintenance of the project.
- Prior to construction, and in accordance with the provisions of Section 221 of Public Law 91-611, the sponsor will enter into a contract with the Government whereby the sponsor will grant the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the sponsor owns or controls for access to the project, for the purpose of inspection, and, if necessary, for the purpose of completing, operating, repairing, maintaining and rehabilitating the project. If an inspection shows that the sponsor, for any reason, is failing to complete, operate, repair, maintain or rehabilitate the project in accordance with the assurances hereunder, the Government will send a written notice to the sponsor. If the sponsor persists in such failure for thirty (30) calendar days after receipt of the notice, then the Government shall have a right to enter, at reasonable times and in a reasonable manner, upon the land that the sponsor owns or controls for access to the project for the purpose of completing, operating, repairing, maintaining and rehabilitating the project. No completion, operation, repair, maintenance, or rehabilitation by the Government shall operate to relieve the sponsor of responsibility to meet its obligations as set forth in the Agreement, or to preclude the

Government from pursuing any other remedy at law or equity to assure faithful performance pursuant to the Agreement.

The City of Muscatine has reviewed the draft model Section 205 PCA and has found its provisions to be acceptable, as stated in their letter dated November 20, 2002 (Appendix B).

**3) Financial Analysis.** The City of Muscatine, Iowa, has the willingness and capability to finance its share of the cost of constructing this local flood protection project. A Statement of Financial Capability and Financing Plan will be submitted, along with the PCA, with the final Detailed Project Report (DPR).

**(4) Real Estate Requirements.** The City of Muscatine is the local sponsor for the Mad Creek at Muscatine, Iowa, Section 205 Flood Damage Reduction Project. The proposed project will require 7.80 acres Temporary Work Area Easement, 4.13 acres Borrow Easement, 0.6 acre Channel Improvement Easement, 0.15 acre Floodwall Easement, 0.378 acre Flood Protection Levee Easement, and 0.9 acre Fee simple title. The estimated cost for lands, easement, rights-of-way, relocations and dredged material placement areas (LERRD) is \$598,000. A model Project Cooperation Agreement will be executed after project approval. Detailed real estate requirements are included in Appendix F - Real Estate Plan.

## 5. SUMMARY OF COORDINATION, PUBLIC VIEWS AND COMMENTS

**a. Coordination.** Throughout a feasibility study, the Corps of Engineers strives to inform, educate, and involve the many groups who may have an interest in the study. This coordination is paramount to assuring that all interested parties have the opportunity to be part of the study process.

One process used for coordination is the public involvement process. Public involvement is the exchange of information with various segments of the public. It attempts to reduce unnecessary conflict and achieve consensus by opening and maintaining channels of communication with the public in order to give full consideration to public views and information in the planning and decision-making processes. Content analysis is the method employed to identify public opinion, study concerns, and potential controversy. It ensures that the public involvement plan is responsive to the level of interest and concern expressed by the public, and it assesses the effectiveness of the public involvement techniques.

**b. Public Views and Comments.** In an earlier study (the Initial Assessment), the Corps of Engineers identified four primary alternatives for increasing flood protection to the areas along Mad Creek and Geneva Creek. These alternatives were further studied in the Section 205 Flood Reduction Study. The main forum for receiving comments during this study was through the study team's coordination with the non-Federal sponsor, the City of Muscatine. Meetings were held between the Corps of Engineers study team and city officials and representatives at critical stages throughout the study.

A broader forum for soliciting comments was a public open house, described in more detail below. The open house process and comments are described in more detail below. The open house attendees were offered comment sheets to express their concerns and comments. Following the open house, the comment sheet responses were documented and analyzed and the results were distributed to all study team members for use in the plan formulation process.

In March 2000, an open house invitation was mailed to a distribution list of nearly 250 addresses including congressional representatives; Federal, State, county, and city officials; businesses, media; and members of the public. The purpose of the open house was to meet with the public to exchange information about the study and potential benefits and problems that may be associated with any of the alternatives.

The open house was held on April 11, 2000, in Muscatine, Iowa. Approximately 25 members of the public attended the open house. A comment sheet was offered to the public for feedback; 9 were returned.

Overall, the majority of those who returned a comment sheet agreed:

- That they were able to discuss the alternatives with Corps of Engineers representatives on a one-to-one basis;
- That their questions about the alternatives were answered; and
- That the information provided about the alternatives was relayed in an understandable manner and that they had a better understanding of the alternatives after attending the open house.

The comment sheet also included a statement about the acceptability of the four primary alternatives for reducing flood damages.

- Respondents either agreed or were neutral that “raising the existing floodwall and levee system along Mad Creek” was acceptable.
- A strong majority agreed that “constructing stormwater detention reservoirs north of Muscatine to reduce peak flows” was acceptable.
- A majority of the respondents agreed that “a combination of floodwalls and levees and stormwater detention reservoirs” was acceptable.
- However, the majority of respondents disagreed that “an enhanced early flood-warning system to better react to flash floods” was acceptable.

Other comments received at the open house included concerns about flash flood protection, backwater flooding, storm sewer backup, and impacts of runoff. A comment about dredging and straightening some areas of Mad Creek was offered, as well as the need to keep flood plain data up to date.

The comments received at the open house were provided to the study team members for consideration and use in their analysis of the potential alternatives.

**c. Draft Detailed Project Report Released.** In August 2002, an announcement was mailed to a distribution list of nearly 250 addresses including congressional representatives; Federal, State, county, and city officials; businesses, media; and members of the public. The mailing announced the completion of the draft Detailed Project Report, the study findings and selected plan, and offered the public the opportunity to comment on the report. A copy of the announcement and the comments received are located in Appendix H.

**d. Summary.** The goals of the coordination process for the Mad Creek, Muscatine, Iowa, Flood Damage Reduction Study were to inform, educate, and involve the public and solicit feedback through open communication and to include in the plan formulation process all publics interested in and affected by the study recommendation(s). These goals were met by providing City officials and representatives and the public opportunities to become informed and educated about, and involved in, the study by providing feedback to the study team. The feedback was used by the study team to shape the plan formulation process and to develop the recommended plan. The study plan that is included in this report has been influenced by the public involvement process.

## 6. RECOMMENDATION

I recommend that the “selected plan” described herein be constructed under the authority of Section 205 of the 1948 Flood Control Act, as amended, with such modifications as, in the discretion of the Chief of Engineers, may be advisable, at a total cost to the United States presently estimated at \$3,445,000, with all annual operation, maintenance, and replacement costs to be the responsibility of the non-Federal sponsor.

Section 205 local flood protection projects are subject to cost sharing in accordance with Public Law 99-662, the Water Resources Development Act of 1986. The non-Federal share of the cost will be \$1,205,750, which is comprised of credits for lands, easements, rights-of-way, relocations and disposals (LERRDs), and a minimum 5 percent cash contribution.

Accordingly, I recommend that the project be funded and constructed subject to cost-sharing and financing arrangements that are acceptable to the Chief of Engineers, the Secretary of the Army, and the non-Federal sponsor.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program, nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding.

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(Date)

William J. Bayles  
Colonel, U.S. Army  
District Engineer

**APPENDIX A**

**HYDROLOGY AND HYDRAULICS**

**APPENDIX B**

**ECONOMIC ANALYSIS**

**APPENDIX C**

**GEOTECHNICAL CONSIDERATIONS**

**APPENDIX D**

**ENVIRONMENTAL ASSESSMENT**

**APPENDIX E**

**HAZARDOUS, TOXIC, AND RADIOLOGICAL WASTE (HTRW) ASSESSMENT**

**APPENDIX F**

**REAL ESTATE PLAN**

**APPENDIX G**

**COST ESTIMATES – ALTERNATIVES AND SELECTED PLAN**

**APPENDIX H**

**PERTINENT CORRESPONDENCE**

**APPENDIX I**

**FINAL PROGRAMMATIC AGREEMENT**

**APPENDIX J**

**STRUCTURAL ANALYSIS**

**APPENDIX K**

**DISTRIBUTION LIST**

**APPENDIX L**

**PLATES**