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110th Congress, 1st Session – – – – – – – – – – – – – – House Document 110–64

FLOOD DAMAGE REDUCTION PROJECT PLAN

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY FOR CIVIL WORKS, THE DEPARTMENT OF DEFENSE

TRANSMITTING

NOTIFICATION THAT THE SECRETARY OF THE ARMY SUPPORTS THE AUTHORIZATION AND PLANS TO IMPLEMENT THE FLOOD DAMAGE REDUCTION PROJECT FOR THE DES MOINES AND RACCOON RIVERS, DES MOINES, IOWA

OCTOBER 17, 2007.—Referred to the Committee on Transportation and Infrastructure and ordered to be printed

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HOUSE DOCUMENT NUMBER 110-104

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

OCT 6 2007

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SPEAKER'S ROOM
U.S. HOUSE OF REPS.

Honorable Nancy Pelosi
Speaker of the House
of Representatives
U.S. Capitol Building, Room H-232
Washington, D.C. 20515-0001

Dear Madam Speaker:

In partial response to a resolution adopted by the Committee on Public Works of the House of Representatives on July 1, 1958, and provision of funds in the Energy and Water Development Appropriations Act of 1998, under authority of Section 216 of the Flood Control Act of 1970, the Secretary of the Army recommends authorization of a flood damage reduction project for the Des Moines and Raccoon Rivers, Des Moines, Iowa. The proposal is described in the Report of the Chief of Engineers dated March 28, 2006 which includes other pertinent reports and comments. The views of the State of Iowa, the Department of the Interior and the Environmental Protection Agency are set forth in the enclosed communications. The Secretary of the Army supports the authorization and plans to implement the project through the normal budget process at the appropriate time, considering national priorities and the availability of funds.

The recommended plan provides for increased flood damage reduction along the Des Moines and Raccoon Rivers to the areas of Birdland Park, Central Place and downtown Des Moines. The flood damage reduction features of the recommended plan consist of constructing 7,700 feet of levee and 440 feet of retaining wall with one closure structure generally along and extending the existing non-Federal levee at Birdland Park; constructing 5,900 feet of levee generally along and extending the existing non-Federal Central Place levee; and modifying three existing pump stations. The recommended plan also includes modification to nineteen closure structures in the existing Federal downtown levee system. The recreation features include 5,100 feet of recreational trail along the Birdland Park levee with access to Riverview Park and landscaping along the levee crossing Riverview Park. Compensatory mitigation to offset unavoidable environmental impacts of the project will be accomplished through the creation of 13 to 16 acres of emergent wetland, open water, upland forest, and herbaceous upland buffer at the Chichaqua mitigation site, northeast of Des Moines. Further compensation includes approximately 5 acres of bottomland forest enhancement, and upland forest creation on the riverside of the levee at Central Place. The recommended plan is the locally preferred plan (LPP). The LPP has greater net benefits than smaller scaled plans and is smaller in scope and less costly than the national economic development plan. The LPP would provide the maximum level of flood damage reduction desired by the non-Federal sponsor.

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Based on October 2006 price levels, the total first cost of the recommended plan is estimated at $10,780,000. The total first cost of the project includes approximately $10,516,000 for flood damage reduction, which includes $305,000 for mitigation, and approximately $264,000 for recreation. In accordance with the cost sharing provisions of Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended, flood damage reduction features would be cost shared 65 percent Federal and 35 percent non-Federal and recreation features would be cost shared 50 percent Federal and 50 percent non-Federal. The overall Federal share of the estimated total first cost of the project would be $6,967,000 and the non-Federal share would be $3,813,000, comprised of approximately $899,000 in lands, easements, rights-of-way, relocations, and dredged material disposal areas (LERRD), $539,000 as five percent cash, and a remaining cash balance of $2,375,000. The City of Des Moines, Iowa, the non-Federal cost sharing sponsor, would be responsible for providing the non-Federal cost share of all features of the recommended plan and all the operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of the project after construction, a cost currently estimated at $32,000 per year. Average annual flood damage reduction benefits attributed to the plan are estimated at $1,765,000, and the flood damage reduction benefit-cost ratio is 2.8 to 1. Average annual recreation benefits are $135,000 and the recreation benefit-cost ratio is 8.4 to 1. The net annual flood damage reduction and recreation benefits for this plan are $1,250,000.

The Office of Management and Budget advises that there is no objection to the submission of the report to Congress. A copy of its letter is enclosed. I am providing a copy of this transmittal and the OMB letter dated June 25, 2007, to the House Subcommittees on Energy and Water Development, and Water Resources and Environment in accordance with the requirements of the Fiscal Year 2006 Omnibus Appropriations Act (P.L. 109-103).

Very truly yours,

John Paul Woodley, Jr.

John Paul Woodley, Jr.
Assistant Secretary of the Army
(Civil Works)

Enclosures

V

8 Enclosures

1. Report of the Chief of Engineers, March 28, 2006
2. Telecon with USFWS on Endangered Species requirements, August 29, 2005
3. Copy, State of Iowa letter to USACE for water quality certification, August 23, 2005
4. Copy, State of Iowa letter to USACE, December 9, 2005
5. Copy, Dept of the Interior letter to USACE, November 18, 2005
6. Copy, EPA e-mail to USACE, December 1, 2005
7. OMB Clearance Letter, June 25, 2007
8. Feasibility Report and Environmental Assessment Statement, December 2005

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO ATTENTION OF:

MAR 2 8 2008

CECW-PC (1105-2-10a)

SUBJECT: Des Moines and Raccoon Rivers, Des Moines, Iowa

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on flood damage reduction in the vicinity of Des Moines, Iowa. It is accompanied by the report of the district and division engineers. These reports are an interim response to a resolution by the Committee on Public Works of the House of Representatives, adopted July 1, 1958. This report was also prepared in response to the provision of funds in the Energy and Water Development Appropriations Act of 1998, under the authority of Section 216 of the 1970 Flood Control Act, which authorizes the Secretary of the Army to review the operation of projects which were constructed by the Corps of Engineers when found advisable due to significant changed physical, economic, or environmental conditions. Preconstruction engineering and design activities for the Des Moines and Raccoon Rivers project will be continued under these authorities.

2. The reporting officers recommend authorization of a project for flood damage reduction and recreation for Des Moines, Iowa. The recommended plan would provide increased flood protection along the Des Moines and Raccoon Rivers to the areas of Birdland Park, Central Place and downtown Des Moines. The flood damage reduction features of the recommended plan consist of constructing 7,700 feet of levee and 440 feet of retaining wall with one closure structure generally along and extending the existing non-Federal levee at Birdland Park; constructing 5,900 feet of levee generally along and extending the existing non-Federal Central Place levee; and modifying three existing pump stations. The recommended plan also includes modification to nineteen closure structures in the existing Federal downtown levee system (downtown, east, west, and south levees) including permanently closing 7 levee closures, reducing the size of 11 levee closures, and installing gates at existing pedestrian walkway closures at the Simon Estes Amphitheater. The recreation features include 5,100 feet of recreational trail along the Birdland Park levee with access to Riverview Park and landscaping along the levee crossing Riverview Park.

3. Based on October 2005 price levels, the total first cost of the recommended plan is estimated at $10,500,000. The total first cost of the project includes approximately $10,240,000 for flood damage reduction and approximately $260,000 for recreation. In accordance with the cost sharing provisions of Section 103 of the Water Resources Development Act (WRDA) of 1986,

as amended, flood control features would be cost shared 65 percent Federal and 35 percent non-Federal. Thus the Federal cost of the flood control features is estimated at $6,656,000 and the non-Federal cost is estimated at $3,584,000. The estimated total first cost also includes a separable recreation trail. This feature is estimated at $260,000; and based on cost sharing requirements of Section 103 of WRDA 1986, it would be shared 50 percent Federal and 50 percent non-Federal. The overall Federal share of the estimated total first cost of the project would be $6,800,000 and the non-Federal share would be $3,700,000. The City of Des Moines, Iowa, is the non-Federal cost sharing sponsor for all features of the plan. The City of Des Moines would be responsible for the operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of the project after construction, a cost currently estimated at $30,000 per year. This includes $29,000 per year for flood damage reduction and $1,000 per year for recreation. Equivalent annual costs, based on a discount rate of 5 1/8 percent and a 50-year period of analysis for flood damage reduction are estimated at $642,000 and for recreation are estimated at $16,000, including OMRR&R, for a total of $658,000. Equivalent annual benefits for flood damage reduction are estimated at $1,667,000 and for recreation are estimated at $127,000, for a total of $1,794,000. This results in equivalent annual net benefits of $1,025,000 for flood damage reduction and $111,000 for recreation for total equivalent annual net benefits of $1,136,000. The benefit-to-cost ratio for flood damage reduction is 2.6; and the benefit-to-cost ratio for recreation is 7.9; and the overall project benefit-to-cost ratio is 2.7 to 1. The recommended plan is a locally preferred plan (LPP). The LPP has greater net benefits than smaller scaled plans and is smaller in scope and less costly than the national economic development (NED) plan. The LPP would provide the maximum level of protection desired by the non-Federal sponsor.

4. The reporting officers estimate that there is a greater than 95 percent probability that the Birdland Park and Central Place levee segments would protect adjacent areas from a flood which has a 0.2 percent chance of occurring in any year (500-year flood). These levee segments would reduce expected annual flood damage in the Birdland Park and Central Place areas by more that 98 percent. The selected plan would substantially increase the reliability of closure structures in the downtown levee system for floods which have less than a 1 percent chance of occurrence in any year (greater than a 100-year flood). The project would also reduce the threat to loss of life and reduce health and safety services disruptions. The recreation features are consistent with proposed recreational improvements to enhance the riverfront in downtown Des Moines. Unavoidable environmental impacts would be fully mitigated by the creation of 13 to 16 acres of emergent wetland, open water, upland forest, and herbaceous upland buffer at the Chichaqua mitigation site, northeast of Des Moines. Further compensation includes approximately 5 acres of bottomland forest enhancement, and upland forest creation on the riverside of the levee at Central Place.

5. Washington level review indicates that the plan recommended by the reporting officers is environmentally justified, technically sound, cost effective and socially acceptable. The plan conforms with essential elements of the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation

Studies and complies with other administration and legislative policies and guidelines. Also, the views of interested parties, including Federal, State and local agencies, have been considered.

6. I concur in the findings, conclusions and recommendation of the reporting officers. Accordingly, I recommend that the plan described herein be authorized, with such modifications as in the discretion of the Chief of Engineers may be advisable. This recommendation is subject to cost sharing, financing, and other applicable requirements of Federal and State laws and policies, including Section 103 of WRDA 1986, as amended by Section 210 of WRDA 1996. Further, this recommendation is subject to the non-Federal sponsor agreeing to comply with all applicable Federal laws and policies, and that it shall be responsible for the following items of local cooperation:

a. Provide a minimum of 35 percent, but not to exceed 50 percent, of total project costs allocable to structural flood control, and 50 percent of total project costs allocable to recreation as further specified below:

1. Enter into an agreement which provides, prior to execution of the project cooperation agreement, 25 percent of design costs;

2. Provide, during the first year of construction, any additional funds needed to cover the non-federal share of design costs;

3. Provide, during construction, a cash contribution equal to 5 percent of total project costs allocable to structural flood control;

4. Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, and maintenance of the project;

5. Provide or pay to the Federal Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

6. Provide, during construction, any additional costs necessary to make its total contribution equal to at least 35 percent of total flood control costs and 50 percent of total recreation costs;

b. Provide 100 percent of the total recreation costs that exceed an amount equal to 10 percent of the Federal share of total flood control costs;

c. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement;

d. Do not use Federal funds to meet the non-Federal Sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized;

e. Operate, maintain, repair, replace and rehabilitate the project, or functional portion of the project, including mitigation, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

f. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the Non-Federal Sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall relieve the Non-Federal Sponsor of responsibility to meet the Non-Federal Sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;

g. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors;

h. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the initial construction, periodic nourishment, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the Non-Federal Sponsor with prior specific written direction, in which case the Non-Federal Sponsor shall perform such investigations in accordance with such written direction;

i. Assume, as between the Federal Government and the non-Federal Sponsor, complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, periodic nourishment, operation, or

maintenance of the project;

j. Agree that, as between the Federal Government and the Non-Federal Sponsor, the Non-Federal Sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that will not cause liability to arise under CERCLA;

k. Prevent obstructions of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstruction or encroachments) which might reduce the level of protection it affords, hinder operation and maintenance, or interfere with its proper function, such as any new developments on project lands or the addition of facilities which would degrade the benefits of the project;

l. Not less than once each year, inform affected interests of the extent of protection afforded by the project;

m. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total costs of construction of the Project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

n. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5), and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

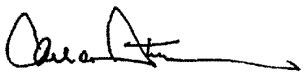
o. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army", and all applicable Federal labor standards and requirements, including but not limited to 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act(formerly 40 U.S.C. 327 *et seq.*) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*) ;

p. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a Non-Federal interest to participate in and comply with applicable Federal floodplain management and flood insurance programs, prepare a flood plain management plan within one year after the date of signing a Project Cooperation Agreement, and implement the plan not later than one year after completion of construction of the project;

q. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, necessary for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act; and,

r. Provide and maintain recreation features, such as appropriate roads, parking areas, and other public use facilities, open and available to all on equal terms.

7. The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to the Congress, the City of Des Moines as the non-Federal sponsor, the State, interested Federal agencies, and other parties will be advised of any significant modifications and will be afforded an opportunity to comment further.



CARL A. STROCK
Lieutenant General, U.S. Army
Chief of Engineers

CONVERSATION RECORD	TIME	DATE
	10:00	29 August 2005

TYPE: [ ] VISIT [ ] CONFERENCE [x] TELEPHONE [ ] INCOMING [ ] OUTGOING

Location of Visit/Conference:

NAME OF PERSON(S) CONTACTED OR IN CONTACT WITH YOU	ORGANIZATION (Office, dept., bureau, etc.)	TELEPHONE NO:
Joe Slater	USFWS, Region 3	309-793-5800 x208

ROUTINE

NAME/SYMBOL	INI

SUBJECT: Biological Assessment

SUMMARY:

Ken Cook, Rock Island District Corps of Engineers, recieved a return phone call from Joe Slater, USFWS, Region 3 biologist pertaining to the Des Moines and Raccoon River Flood Damage Reduction Project.

This conversation regarded the addition of wording in the project document that through informal consultation during development of alternatives and mitigation, a biological assessment is not required for the Indiana bat or bald eagle. Mr. Cook requested that the following wording be inserted into the document to support this recommendation: 'Informal consultation between the USFWS and the District determined that a biological assessment would not be required for these species under the proposed project."

Mr. Slater concurred with the wording adding that in his view a biological opinion would find that "no adverse impacts are likely" to the species under consideration.

ACTION REQUIRED

Add the above wording to the document and add this conversation record to the Statement of Findings package

NAME OF PERSON DOCUMENTING CONVERSATION	SIGNATURE	DATE
Ken Cook		

ACTION TAKEN

Wording and conversation record added

SIGNATURE	TITLE	DATE

CONVERSATION RECORD

OPTIONAL FORM 271 (12-76)
DEPARTMENT OF DEFENSE

Fields of Opportunities

STATE OF IOWA

THOMAS J. VILSACK, GOVERNOR
SALLY J. PEDERSON, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
JEFFREY R. VONK, DIRECTOR

August 23, 2005

RECEIVED
AUG 2 4 2005
CEMVR-OD-P

U.S. Army Corps of Engineers
Rock Island District
Colonel Duane P. Gapinski
Clock Tower Building – P.O. Box 2004
Rock Island, IL 61204-2004

Dear Colonel Gapinski:

After reviewing your request for State 401 Water Quality Certification, the Iowa Department of Natural Resources has issued the enclosed Certification. Please read the attached conditions carefully before beginning work on the project.

If you have any questions or comments about the certification or any conditions contained therein, please contact me at the address shown below or call (515) 281-6615.

Sincerely,

Christine M. Schwake

Christine M. Schwake
Environmental Specialist

c: Mr. Steve Russell, U.S. Army Corps of Engineers, Rock Island District, Clock Tower Building, P.O. Box 2004, Rock Island, IL 61204-2004

STATE OF IOWA

THOMAS J. VILSACK, GOVERNOR
SALLY J. PEDERSON, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
JEFFREY R. VONK, DIRECTOR

December 9, 2005

Patricia Bee
U.S. Army Corps of Engineers
CECW-P (SA), Attn: CECW-PC
7701 Telegraph Road
Alexandria, VA 22315-3860

RE: Environmental Review for Natural Resources
Feasibility Report, Flood Damage Reduction for the Des Moines and Raccoon Rivers Project, Des Moines, IA, with Integrated Environmental Assessment, September, 2005

Dear Ms. Bee:

The Conservation and Recreation Division of the Iowa Department of Natural Resources has reviewed this report and has no comment.

This letter is a record of review for protected species, rare natural communities, state lands and waters in the project area, including review by personnel representing state parks, preserves, recreation areas, fisheries and wildlife but does not include any potential comment from the Environmental Services Division of this Department.

If you have any questions about this letter or if you require further information, please contact Keith Dohrmann at (515) 281-8967.

Sincerely,

DIANE FORD-SHIVVERS, SUPERVISOR
POLICY AND COORDINATION
CONSERVATION AND RECREATION DIVISION

DFS:kd

CC: Christine Schwake, Water Quality Bureau, Iowa DNR (by email)
U.S. Army Corps of Engineers – Rock Island District

FILE COPY: Keith L. Dohrmann

05-4260L.doc

United States Department of the Interior
OFFICE OF THE SECRETARY
Washington, DC 20240

TAKE PRIDE IN AMERICA

NOV 18 2005

ER 05/899

Mr. Thomas W. Waters
Chief, Policy and Policy Compliance Division
Directorate of Civil Works
Headquarters, U.S. Army Corps of Engineers
CECW-P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860

Dear Mr. Waters:

As requested, the U.S. Department of the Interior has reviewed the Chief of Engineers' Proposed Report on the Flood Damage Reduction Project, Des Moines and Raccoon Rivers, Polk County, Iowa.

The Department does not object to the proposed project and has no comments to offer. The point of contact is Ms. Loretta Sutton, 202-208-7565. We appreciate the opportunity to review the Chief's Proposed Report and supporting documents.

Sincerely,

for Willie R. Taylor
Director, Office of Environmental
Policy and Compliance

Bee, Patricia L HQ02

From: Cothern.Joe@epamail.epa.gov
Sent: Thursday, December 01, 2005 11:14 AM
To: Bee, Patricia L HQ02
Subject: Chiefs report on the Des Moines and Raccoon Rivers, Des Moines, Iowa

Dear Ms. Bee;

Thank your for your telephone calls requesting EPA's input on the subject project. Through our review, EPA found the analysis and documentation to be very comprehensive, and that formal comment was not necessary. If the USACE receives comments from other reviewers where EPA's expertise may be needed, please call me.

Sincerely,

Joseph E. Cothern
NEPA Team Leader
U.S. Environmental Protection Agency
Region 7 - Kansas City
(913) 551-7148
cothern.joe@epa.gov

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

June 25, 2007

The Honorable John Paul Woodley, Jr.
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon
Washington D.C. 20310-0108

Dear Mr. Woodley:

As required by Executive Order 12322, the Office of Management and Budget has completed its review of your recommendation concerning the General Reevaluation Report for Des Moines and Raccoon Rivers.

Your recommendation for this project is consistent with the policy and programs of the President. The Office of Management and Budget does not object to you submitting this report to Congress.

Sincerely,

Richard A. Mertens
Deputy Associate Director
Energy, Science, and Water

FEASIBILITY REPORT
FLOOD DAMAGE REDUCTION
FOR
DES MOINES AND RACCOON RIVERS PROJECT
DES MOINES, IOWA

WITH INTEGRATED
ENVIRONMENTAL ASSESSMENT

VOLUME 1

December 2005

US Army Corps
of Engineers
Rock Island District

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
CLOCK TOWER BUILDING - P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO http://www.mvr.usace.army.mil

FEASIBILITY REPORT
FLOOD DAMAGE REDUCTION
FOR
DES MOINES AND RACCOON RIVERS PROJECT
DES MOINES, IOWA

WITH INTEGRATED
ENVIRONMENTAL ASSESSMENT

Executive Summary

The primary purpose of this study is to evaluate and determine the feasibility of implementing flood damage reduction improvements for the City. The USACE, Rock Island District and the City have completed this feasibility report for flood damage reduction with integrated Environmental Assessment. The report contains results of a comprehensive investigation of the flooding problems along the Des Moines and Raccoon Rivers and primary tributaries within the city limits of Des Moines.

This study was prepared in response to a resolution adopted by Congress on July 1, 1958, following appropriation of funds in the Energy and Water Development Appropriations Act of 1998, and under the authority of Section 216 of the 1970 Flood Control Act (Public Law 91-611). This act provides authority for the Secretary of the Army to review the operation of projects completed by the Corps of Engineers when found advisable due to significantly changed physical or economic conditions, and to report to Congress with recommendations for modifying structures or their operation for improving the quality of the environment or in the overall public interest. The completed project under review is Des Moines, Iowa, (also known as the Des Moines Local Flood Protection Project) which was authorized for construction by Section 10 the Flood Control Act of 1944 (Public Law 78-534).

The City of Des Moines has been subject to frequent flooding that impacts large numbers of residential, commercial, and industrial properties. During the Great Flood of 1993, Polk County suffered more than $152,000,000 in flood damages, mostly in the Des Moines metropolitan area. In addition, Des Moines was without water service for more than a week causing closure of most businesses and industries in the city. More than 3,000 properties were damaged in this event.

The Birdland Park and Central Place levees failed during the 1993 flood event and do not provide reliable flood protection, placing nearly 200 homes and businesses at risk. Downtown Des Moines also flooded in 1993 due to incomplete installation of levee closures. This levee system has a large number of closures which decreases the reliability of the system, increasing the flood threat for hundreds of commercial, industrial, and residential structures. Improvements to closures and reduction in the number of closures in the downtown levee system would reduce operation and maintenance costs and improve safety during flood events. Project implementation would be coordinated with proposed recreational improvements to enhance the riverfront in downtown Des Moines. Homes and businesses along selected portions of Walnut Creek, Fourmile Creek, and Leetown Creekway are also subject to frequent flash floods.

Alternative plans were developed and evaluated for each of the 11reaches included in the study. Alternatives included levees and floodwalls, reservoirs, channel improvements, and nonstructural measures such as flood warning systems and relocation/removal of existing structures. Preliminary screening focused detailed analysis on plans that provided the most benefits and potential to be economically justified. Alternatives that were developed and evaluated in detail include:

- three levee alignments at three levee heights for an improved levee to protect the Birdland Park area;
- an improved and extended recreational trail at Birdland Park;
- three levee heights for an improved levee to protect the Central Place area;
- raising the levees and floodwalls of the existing downtown levee system;
- improving the closures in the existing downtown levee system; and
- constructing new levees along portions of Walnut Creek and Fourmile Creek.

No modifications or improvements were economically justified in 6 of the 11 reaches evaluated.

The recommended plan consists of 7,700 feet of earthen levee and associated structures to provide 500-year flood protection to the Birdland Park area; an asphalt-surfaced recreational trail on the Birdland Park levee; 5,900 feet of earthen levee and associated structures to provide 500-year protection to the Central Place area; elimination of 7 closures and improvements to 12 closures in the existing downtown flood protection system; and development of 18 to 21 acres of open water, riparian, and wetland habitat as environmental mitigation. The recommended plan would provide improved flood protection to over 850 residential properties and 650 commercial/ industrial properties along the Des Moines and Raccoon Rivers in Des Moines with estimated 500-year flood damages of over $325 million. Because there were no significant issues affecting the natural and human environment, an Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) were prepared for this project.

Estimated Implementation Costs: (October 2005 price level)	**Recreation** (50% Cost Share)	**Flood damage Reduction** (65%-35% Cost Share)	**Total Share**
Federal Share	$127,000	$6,655,000	$6,782,000
Non-Federal City of Des Moines Share	$127,000	$3,582,000	$3,709,000
Total Project Cost	$254,000	$10,237,000	**$10,491,000**

5 1/8 discount rate over a 50-year evaluation period

The recommended plan's Benefit-Cost Ratio is 2.7. The recommended plan, which is also the locally preferred plan, reconstructs 13,600 feet of levee at Birdland Park and Central Place, improves the reliability of closures in the downtown area by eliminating 7 and reconfiguring 12 other closures and constructs a recreational trail on top of the levee connecting the Neal Smith Trail with Riverview and McHenry Parks.

PREFACE

The City of Des Moines, Iowa (City) surrounds the confluence of the Des Moines and Raccoon Rivers in Polk County, in central Iowa. These rivers drain almost 10,000 square miles in northern and central Iowa and in southwestern Minnesota. Des Moines has experienced periodic severe flooding since floods were first recorded in 1851. Between 1851 and 1903, major floods occurred every 3 to 11 years, mostly in the months between April and July. Major floods occurred in both 1902 and 1903, while additional flooding occurred in 1947, 1965, 1969, and, most recently, in 1993.

The Great Flood of 1993 was unprecedented in magnitude and severity across Iowa, with seven deaths. The greatest economic losses occurred in cities on the floodplain. Des Moines, located in the center of the flood region, became the largest U.S. city to lose its water supply when its water treatment plant flooded. More than 250,000 people lost drinking water for 19 days in the summer. Water pipes, contaminated by floodwaters carrying sewage and agricultural chemicals, had to be flushed out before the municipal water supply was reconnected. Economic losses in Des Moines totaled approximately $716 million.

The fall and winter of 1992 had record rains, with the fifth wettest November on record. Heavy rains in March 1993 combined with snowmelt in the northern Mississippi Basin, which raised water levels throughout the northern and central basin. Throughout Iowa, repeated heavy thunderstorm events in the spring of 1993 coincided with the third highest June precipitation in 121 years. Portions of downtown, the Birdland Park Neighborhood, and the Central Place Neighborhood were flooded, causing damages to numerous homes and businesses. The downtown west levee protected area was flooded when floodwaters entered along a railroad sandbag closure location. The downtown east levee was almost breached when a tree growing near the levee tipped over and the levee scoured quickly. In July, the Saylorville Reservoir reached flood stage and ultimately overflowed the emergency spillway. Fourmile Creek and Walnut Creek, tributaries to the Des Moines River and Raccoon River, also experienced moderate to major flash flooding in July from an additional 3 to 5 inches of rain in a narrow band from Des Moines westward along I-80, contributing further to flooding. The flood was officially declared over in October 1993.

In 1996, the City requested that the U.S. Army Corps of Engineers (USACE) conduct a reconnaissance plan to evaluate alternatives for flood damage reduction, environmental restoration, and related water and land resources. A reconnaissance study was initiated in 1998 as a result of the provision of funds for this purpose in the Energy and Water Development Appropriations Act of 1998. The reconnaissance study recommended that a detailed feasibility study be conducted. The USACE, Rock Island District (District) and the City signed a Feasibility Cost Sharing Agreement (FCSA) in September 1999, initiating the feasibility study that is the subject of this report.

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FEASIBILITY REPORT
DES MOINES AND RACCOON RIVERS PROJECT
FLOOD DAMAGE REDUCTION
DES MOINES, IOWA

1. STUDY AUTHORITY

This report was prepared in response to a Congressional resolution, which reads as follows:

"Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on the Des Moines River, contained in House Document 651, 78th Congress, with particular reference to the Upper Des Moines River and the tributaries thereof, to determine the feasibility and justification of improvements for flood control and related purposes." (Adopted July 1, 1958)

The report was also prepared in response to the provision of funds in the Energy and Water Development Appropriations Act of 1998, under the authority of Section 216 of the 1970 Flood Control Act, which reads:

"The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significant changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest."

The completed project under review is Des Moines, Iowa, (also known as the Des Moines Local Flood Protection Project) which was authorized for construction by Section 10 the Flood Control Act of 1944 (Public Law 78-534) which reads:

"The project on the Des Moines River for local flood protection of Des Moines, Iowa is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 651, Seventy-eighth Congress, second session, at an estimated cost of $270,000."

The Letter of the Chief of Engineers, United States Army, dated December 13, 1943, included in House Document No. 651 recommends *"the construction of local improvements for flood control at the city of Des Moines, Iowa in general accordance with the plans of the district engineer as shown on the accompanying drawings at an estimated first cost to the United States of $270,000; subject to the condition that responsible local agencies give assurances satisfactory to the Secretary of War that they will (1) provide without cost to the United States all lands, easements, and rights-of-way necessary for construction of the works, (2) bear the expense of repairs and provision of gates on existing drains and of raising the railroad bridges, (3) hold and save the United States free from damages resulting from construction of the improvements, and (4) maintain and operate all works after completion in accordance with regulations prescribed by the Secretary of War including insurance against encroachments on, and obstructions of, the flood channel which would detract from the flood-control value of the improvements;"*

The recommended project is further described in the Survey of Des Moines River, Iowa included in House Document No. 651 as: *"approximately 18,900 feet of new levees, 16,300 feet of reconstructed levees, and 2,400 feet of concrete curb wall."*

The reconnaissance phase was initiated on April 15, 1998 and resulted in the finding that there was a federal interest in conducting a feasibility study. The U.S. Army Corps of Engineers (USACE) approved the Section 905(b) reconnaissance report on December 14, 1998. The City, as the non-federal Sponsor (the Sponsor), and the USACE, Rock Island District (District) initiated the feasibility study on September 13, 1999, by executing a feasibility cost-sharing agreement. This report presents the results of the feasibility study.

2. REPORT PURPOSE AND SCOPE

The primary purpose of this study is to evaluate and determine the feasibility of implementing flood damage reduction improvements for the City. The USACE, Rock Island District (the District), and the City has completed this feasibility report for "Flood Damage Reduction" with integrated Environmental Assessment. The report contains results of a comprehensive investigation of the flooding problems along the Des Moines and Raccoon Rivers and primary tributaries within the City limits of Des Moines. The official name of this effort is "Des Moines and Raccoon Rivers Project (DMRR), Des Moines, Iowa". The investigation includes evaluating current and anticipated water problems and community needs in an array of alternatives that appears to have potential feasibility. The criteria used to evaluate the alternatives are economic, balance between cost and benefit, a reduction or mitigation of environmental impacts, and engineering construction feasibility.

The federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements. The Federal Government views prospective projects from a national point of view, including two requirements for federal participation. The primary requirement calls for substantial benefits to flood control. The second requirement is to produce net benefits which exceed costs. "Federal Interest" in the project is identified when both requirements are satisfied. Environmental impacts are reduced with alternative designs or mitigated by replacement. The federal objective is stated in terms of an expressed desire to alleviate problems and realize opportunities related to the output of goods and services or to increased economic efficiency. The planning process consists of a series of steps that identifies or responds to problems and an opportunity associated with the federal objective and specific State and local concerns, and culminates in the selection of a recommended plan. The process involves an orderly and systematic approach to making determinations and decisions at each step so that the interested public and decision makers in the planning organization can be fully aware of the basic assumptions employed; the data and information analyzed; the areas of risk and uncertainty; the reasons and rationales used; and the significant implications of each alternative plan. This report documents federal interest in flood damage reduction improvements or other water resources improvements within the City, covering a period of analysis of 50 years.

2. A. REPORT CONTENT

This report has three volumes: Volume 1, the main report; Volume 2, technical appendices; and Volume 3, engineering drawings or plates. Volume 1 discusses the overall study process and plan formulation and contains the recommendation of the District Engineer. Also in the main report is an account of the participants in the study, in addition to the coordination that occurred among the public, local officials, environmental groups, outside agencies, etc. Volume 2 consists of 10 appendices, supplementing information in the main report with detailed data and analysis. Volume 3 consists of the engineering drawings, which supplement information in the main report.

2. B. DESCRIPTION OF THE STUDY AREA

The study area is the City in Polk County, Iowa. Specifically the geographic scope of the study is the incorporated City limits of Des Moines, Iowa, that experience flood damage from the Des Moines and Raccoon Rivers, Walnut Creek, Fourmile Creek, and Leetown Creekway (formerly known as 7th Ward Ditch), as shown below in Figure 1.

The upper Des Moines River watershed consists of 6,245 square miles; draining areas in north central Iowa and southwest Minnesota (Figure 1). Saylorville Dam, constructed in 1975 on the Des Moines River, largely mitigates flood damages from the Des Moines River, but significant storm events can still cause flooding throughout the City.

The Raccoon River enters the Des Moines River from the west near the Des Moines central business district and has a drainage area of 3,629 square miles. With no large flood-regulating reservoirs, the Raccoon River exhibits great fluctuations in its flows.

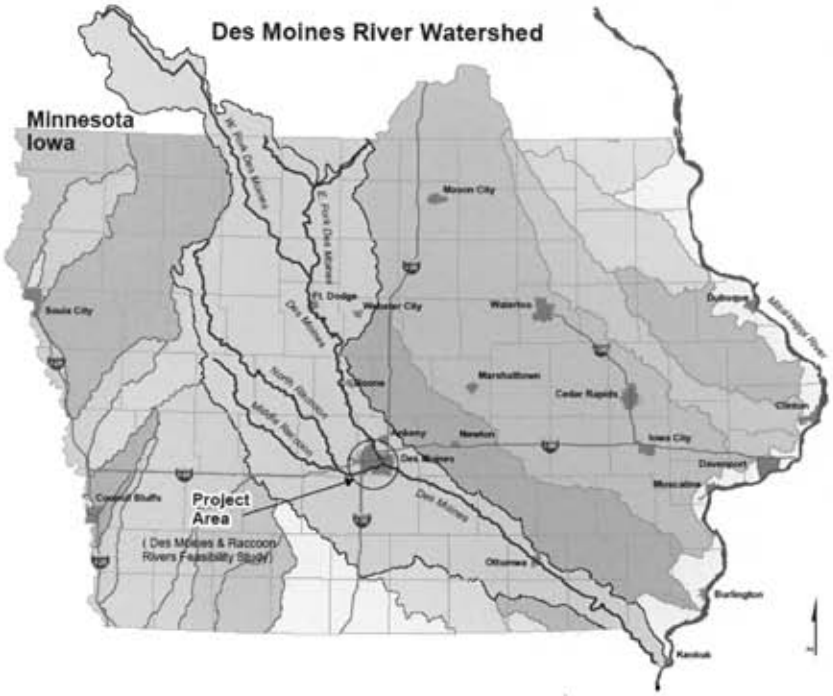

Figure 1: Des Moines River Basin

Other small tributaries of note are Walnut Creek, Fourmile Creek, and Leetown Creekway. Walnut Creek, a tributary of the Raccoon River, confluent approximately 3.5 miles upstream from the confluence of the Des Moines and Raccoon Rivers. This creek, which drains about 85 square miles, has a relatively small floodplain. Fourmile Creek is a major tributary, flowing into the Des Moines River approximately 6 miles below the confluence with the Raccoon River. Leetown Creekway is a smaller tributary of

Fourmile Creek, flowing into Fourmile Creek approximately 1 mile upstream of the confluence with the Des Moines River.

2. C. DESCRIPTION OF REACHES

For this report, there are 11 economically separate project reaches, related to flood damage reduction (Figure 2). In varying degrees, each reach has problems with flooding. Reaches 1 through 8 have existing levees and the remaining three reaches are areas along tributaries to the Des Moines or Raccoon Rivers that experience periodic flooding. The reaches are described below:

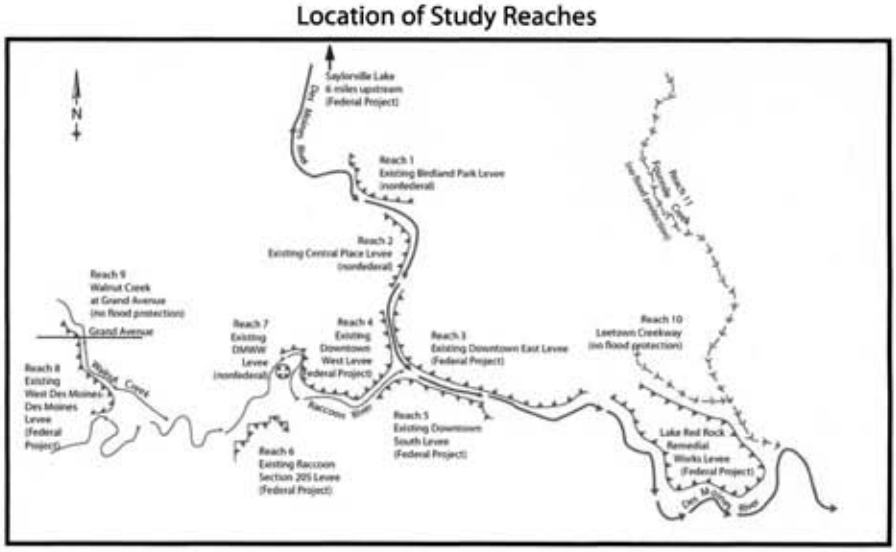

Figure 2: Location of Existing Projects in Study Areas

Reach 1: Birdland Park Levee on the eastern bank of the Des Moines River approximately 2.7 miles upstream of the confluence with the Raccoon River. The levee here was constructed by the City in the early 1950s (Figure 3). The existing levee ties to high ground at each end and is not physically connected to any other levee. University Avenue, elevation 840 feet National Geodetic Vertical Datum (NGVD), isolates Reach 1 from Reach 3.

Reach 2: Central Place Levee on the western bank of the Des Moines River approximately 2 miles upstream of the confluence with the Raccoon River. This levee was constructed by the City in the early 1950s (Figure 10). The existing levee ties to high ground at each end and is not physically connected to any other levee. Center Street (elevation above 805 feet NGVD) isolates Reach 2 from Reach 4.

Reach 3: Downtown East Levee on the eastern bank of the Des Moines River, upstream and downstream of the confluence with the Raccoon River. This levee was constructed as part of the Des Moines Local Protection Project authorized by the 1944 Flood Control Act. The project was designed to provide 100-year flood protection and was completed in 1970 (Figure 13). The existing levee ties to high ground at each end.

Reach 4: Downtown West Levee on the western bank of the Des Moines River and the Northern bank of the Raccoon River, at their confluence. This levee was constructed as part of the Des Moines Local Protection Project authorized by the 1944 Flood Control Act. The project was designed to provide 100-year flood protection and was completed in 1971 (Figure 14). The existing levee ties to high ground at each end and is not physically connected to any other levee.

Reach 5: Downtown South Levee on the south bank of the Des Moines River and the Raccoon River. This levee was constructed as part of the Des Moines Local Protection Project authorized by the 1944 Flood Control Act. The project was designed to provide 100-year flood protection and was completed in 1971 (Figure 15). The existing levee ties to high ground at each end and is not physically connected to any other levee.

Reach 6: Raccoon River Section 205 Levee is a federal levee completed in 2000 under the authority of Section 205 of the Flood Control Act of 1948. The project is located along the south bank of the Raccoon River upstream of Fleur Drive in Des Moines and was designed to provide 100-year flood protection (Figure 16). The existing levee ties to high ground at each end and is not physically connected to any other levee.

Reach 7: Des Moines Water Works Levee surrounds the Des Moines Water Works and was constructed by the City in the 1960s and further improved in 1994 (Figure 17). The existing levee is a ring levee that surrounds the water works and does not connect to high ground.

Reach 8: West Des Moines – Des Moines Project levee along the northern bank of the Raccoon River and western bank of Walnut Creek was constructed by USACE in 1998 under the authority of the Water Resource Development Act of 1986 (Public Law 99-662). The project was designed to provide 100-year flood protection (Figure 18). The existing levee ties to high ground at each end and is not physically connected to any other levee.

Reach 9: Walnut Creek Reach at Grand Avenue is on the east bank of Walnut Creek near Grand Avenue, opposite Reach 8 (Figure 19). There is no existing structural flood protection in this reach.

Reach 10: Fourmile Creek Reach is along both banks of Fourmile Creek south of I-80 (Figure 21). There is no existing structural flood protection in this reach, except the Red Rock Remedial Works levee along the western bank of Fourmile Creek downstream of Leetown Creekway.

Reach 11: Leetown Creekway Reach is along both banks of Leetown Creekway south of Dean Avenue (Figure 22). There is no existing structural flood protection in this reach, except the Red Rock Remedial Works levee along the southern bank of Leetown Creekway downstream of Fourmile Creek.

2. D. FLOOD HISTORY

There are 27 gaging stations within the Des Moines River and Raccoon River Basins. Historical data and gage records indicate that flooding usually occurs between May and July. The rivers will rise in March and April due to snowmelt or early spring showers, which saturate the basin. Flooding can follow in May, June and July as precipitation continues.

Major floods occurred on the Raccoon River in 1917, 1926, 1947, 1958, 1960, 1973 and 1993. Walnut Creek had a major flood in 1973. The primary flood hazard along Walnut Creek is along the right bank where the 100-year flood would inundate the commercial and industrial areas between Center Street and Grand Avenue and a residential area downstream of Grand Avenue.

The Great Flood of 1993 established the flood of record on most streams in the Des Moines metropolitan area. The metropolitan area suffered more than $716,000,000 in flood damages as more than 3,000 structures were inundated. The City was without water and sewer service for more than a week, causing the closure of businesses and industry throughout the county.

3. PRIOR STUDIES, REPORTS, and EXISTING WATER PROJECTS

3. A. PRIOR STUDIES

The USACE and other federal, state, and local entities have conducted numerous studies that are relevant to this planning and design report, including:

Des Moines River, Iowa 15 December 1930	USACE	Report from the Chief of Engineers concluded that improvement of the Des Moines River for navigation, irrigation, waterpower, and flood control, or any combination thereof, was not deemed advisable. The report was submitted in compliance with Section 1 of the River and Harbor Act approved January 21, 1927 directing that surveys be made of certain streams for navigation, flood control, power development, and irrigation, in accordance with House Document 308, 69th Congress, 1st Session; and under the provision of Section 10 of the Flood Control Act approved May 15, 1928.
Survey Report for Flood Control, Des Moines River, Iowa August 15, 1941	USACE	This report recommended construction of Red Rock Reservoir and construction of a system of levees and flood walls to protect the city of Des Moines. This report was included with the Letter of the Chief of Engineers, United States Army, dated December 13, 1943, in House Document Numbered 651, 78th Congress, 2nd Session.
Review Report for Flood Control, Des Moines River, Iowa Interim Report, Main Report 31 May 1953	USACE	This report recommended construction of the Saylorville Reservoir on the Des Moines River. It also investigated potential flood control reservoir locations on the Raccoon River, but no economically justifiable site was found.
Interim Report on Interior Drainage, Des Moines, Iowa, Local Flood Protection Project 8 November 1962	USACE	Recommended that interior drainage considerations be investigated in the interest of flood damage reduction and plans and specifications be prepared accordingly.
Design Memorandum No. 1, General Design Memorandum, Des Moines River at Des Moines, Iowa, Local Flood Protection 21 February 1963	USACE	This document was completed following authorization of the Des Moines Local Protection Project by the Flood Control Act of 1944 (Public Law 78-534), as recommended by the Survey Report for Flood Control, Des Moines River, Iowa, dated August 15, 1941 and approved December 13, 1943 (House Document 651, 78th Congress, 2nd Session). The report recommended improvements to levees in Reaches 3, 4, and 5 in downtown Des Moines.

Supplement No. 1 to General Design Memorandum, Des Moines River at Des Moines, Iowa, Existing Riverwall Sewers and Review of Closing Levee, Reach 5,	18 September 1964 USACE	Recommendation is made in this report to build a levee along Edison Avenue, to provide unimpeded drain to a ponding area, and add a sandbag closure in the freeboard zone at Hillside Avenue.
Supplement No. 2 to General Design Memorandum, Des Moines River at Des Moines, Iowa, Modifications in Stage II, Reach 4 and Stage III, Reach 5,	29 September 1967 USACE	Proposed modifications to the design of the flood protective works on Fleur Drive are described in this report.
Detailed Project Report for Flood Control under Section 205 of the 1948 Flood Control Act, as amended, Fourmile Creek in Des Moines, Iowa	May 1975 USACE	The Report reviews past proposals and programs identifying feasible flood damage reduction and recreation features and recommended no structural improvements or further studies are performed.
Des Moines River Basin, Iowa and Minnesota	June 1975 USACE	This report recommended 100-year flood protection for portions of West Des Moines and Des Moines along the Raccoon River, Walnut Creek, and Jordan Creek. The report concluded that flood control reservoirs on the Raccoon River at Jefferson and on Walnut Creek were not justified. This report was included with the Letter of the Chief of Engineers, United States Army, dated July 22, 1977, in Senate Document No. 96-36, 96th Congress, 1st Session. The report was submitted in compliance with a resolution adopted by Congress on July 1, 1958.
Information Report, Review of a Completed Project at Des Moines, Iowa	September 1978 USACE	This report reviewed the project at Des Moines, Iowa, (also known as the Des Moines Local Flood Protection Project) which was authorized for construction by the Flood Control Act of 1948 (Public Law 78-534). The investigation revealed no economic justification for any of the alternatives considered and the project was concluded.
Reconnaissance Study for Section 205 Flood Control Project, Raccoon River, Des Moines, Iowa	May 1986 USACE	This report identified three feasible flood damage reduction alternatives and recommended a detailed project study for the area near Valley and Fleur Drives.
Definite Project Report, Section 205, Flood Control Project, Raccoon River, Des Moines, Iowa	May 1988 USACE	This report recommended a 100-year levee to protect the mixed residential, commercial and light industrial neighborhood located the area near Valley and Fleur Drives. This levee was built in 1995.

Reconnaissance Report, Section 205 Flood Damage Reduction Project, Des Moines River, Des Moines, Iowa, Birdland Levee		Structural and non-structural alternatives were considered for Birdland Levee system but were not economically justified.
December 1988	USACE	
General Reevaluation Report for Flood Control Project, Raccoon River and Walnut Creek, West Des Moines and Des Moines, Iowa		This report was completed following authorization of the project for flood control: Des Moines River Basin, Iowa and Minnesota (also known as the West Des Moines – Des Moines Project) in the Water Resources Development Act of 1986 (Public Law 99-662). The document recommended a plan to provide 100-year protection along the north bank of the Raccoon River, west bank of Walnut Creek, and east bank of Jordan Creek. This report was subsequently amended by a letter report dated March 1994.
July 1989	USACE	
Expedited Reconnaissance Study, Section 905(b) WRDA 1986 Analysis, Des Moines and Raccoon Rivers, Des Moines, Iowa		This document recommended a more detailed investigation of flood damage reduction measures for the City.
16 November 1998	USACE	
Regulated Frequency Curves and Pool Elevation Frequency Estimates for Des Moines and Iowa River Basins		Des Moines based on Regulated Frequency Curves and Pool Elevation Frequency Estimates for Des Moines and Iowa River Basins
Jan 2002	USACE	

3. B. EXISTING PROJECTS

The following federal and local flood protection projects within the study area have been completed and are contributing to flood damage reduction in and adjacent to the City of Des Moines:

3.B.1. Des Moines, Iowa

(Also known as Des Moines Local Flood Protection Project) This federal flood protection project was authorized by the Flood Control Act of 1944 (Public Law 78-534). The project is located along both banks of the Des Moines River and mouth of the Raccoon River in downtown Des Moines and is designed to provide 100-year flood protection. It includes a system of levees, floodwalls, bridge raises, and gate wells and was completed in 1971. The project was constructed in three separate reaches, designated Reaches 3, 4, and 5, which coincide with the reaches designated in this report.

3.B.2. Red Rock Dam, Iowa

This federal project was authorized by the Flood Control Act of 1944 (Public Law 78-534). The project is located on the Des Moines River downstream of Des Moines, Iowa and is a unit of the comprehensive plan for flood control and other purposes in the Upper Mississippi River region. The 110-foot tall dam has been in operation since 1969 and forms a 19,000-acre lake. The Red Rock Remedial Works levees were constructed along the upper portions of the lake along the east bank of the Des Moines River, the

western bank of Fourmile Creek, and the southern bank of Leetown Creekway to protect existing properties in this area from flooding during high reservoir stages.

3.B.3. Saylorville Lake, Iowa

This federal project was authorized by the Flood Control Act of 1958 (Public Law 85-500) to supplement flood storage in Lake Red Rock and to reduce flooding in the city of Des Moines. The project is located on the Des Moines River approximately 6 miles upstream of Des Moines and has a conservation pool covering about 5,400 acres and a total capacity of 676,000 acre-feet. The 126-foot tall dam was completed in 1975, and the project has been in operation since 1977.

3.B.4. Des Moines River Basin, Iowa and Minnesota

(Also known as the West Des Moines – Des Moines project) This federal project was authorized by the Water Resources Development Act of 1986 (Public Law 99-662). The project is located along the Raccoon River, Walnut Creek, and Jordan Creek in the cities of West Des Moines and Des Moines and is designed to provide 100-year flood protection. The project includes a system of levees, floodwall, pumping plants, closure structures, and gate wells and was completed in 1998. This project has been designated Reach 8 for the purposes of this study.

3.B.5. Raccoon River, Des Moines, Iowa

This federal project was authorized under Section 205 of the Flood Control Act of 1948. The project is located along the south bank of the Raccoon River upstream of Fleur Drive in Des Moines and is designed to provide 100-year flood protection. The project includes a system of levees, floodwall, closure structures, and gate wells and was completed in 2000. This project has been designated Reach 6 for the purposes of this study.

3.B.6. Des Moines Recreational River and Greenbelt, Des Moines River, Iowa

The Des Moines Recreational River and Greenbelt (Greenbelt) was authorized by Congress in the Supplemental Appropriations Act of 1985 (Public Law 99-88) to provide central Iowa with recreation facilities along the Des Moines River. Additional legislation is contained in the Water Resources Development Act of 1986 (Public Law 99-662), the Fiscal Year 1987 Continuing Resolution Act (Public Law 99-500), and the Energy and Water Development Appropriations Act of 1988 (Public Law 100-202). Implementation of projects included in the Greenbelt authority is underway as described in the 2005 Annual Program Management Report, Des Moines Recreational River and Greenbelt, Des Moines River, Iowa, dated January 2005. Completed Greenbelt projects in the Des Moines area include the Simon Estes Amphitheater located on the east bank of the Des Moines River downstream of Locust Street. Additional riverfront recreation facilities are proposed in downtown Des Moines as part of the Principal Riverwalk. These facilities will be designed in coordination with the existing flood protection facilities and any improvements that may be recommended because of this feasibility study.

4. PLAN FORMULATION

In order to formulate a feasible flood protection project and assess the effects of the project, a full array of potential flood protection strategies and plans were considered. Plan comparison evaluations were done initially at a low level of detail in a Reconnaissance Study. This initial study focused on determining what plan, if any, is in the federal interest. If both federal and local interests are found, then a more detailed feasibility study will be prepared.

When formulating a plan for flood damage reduction, it is important to inventory the problems and concerns of the stakeholders and to develop specific measures to address problems. It is also important to identify key existing water resources to determine if there are opportunities to improve or protect them.

Flood protection plans must be found to be economically, environmentally, and socially feasible and are evaluated further in a progressive screening process until a single National Economic Development (NED) plan is defined and documented. The NED plan is the alternative that has the greatest net benefits and is the plan that the Federal Government is most supportive of constructing. Net benefits are defined as the average annual project benefits minus the average annual project costs. Those plans with average annual benefits greater than the average annual costs are considered economically feasible. The Sponsor may identify an alternate plan, provided it is economically feasible. Any additional project features or "betterment" costs within the Locally Preferred Plan will be borne solely by the local Sponsor.

The study team is comprised of representatives from the District and from the City. Study disciplines include planning, engineering, geotechnical, hydrology and hydraulics, economic analysis, surveying, real estate, environmental/cultural, social analysis, and public involvement. A list team members' education and experience can be found in Section 6. D.

4. A. RECONNAISSANCE STUDY FINDINGS

A reconnaissance study that recommended preparation of this feasibility study was initiated in April 1998 and approved in December 1998. The major findings of the reconnaissance study were:

- Existing levees at Birdland Park and Central Place are inadequate to protect the City from large flood events.
- Updated hydraulic modeling is needed to accurately reflect changed hydrologic and physical conditions in the Des Moines area.
- There are opportunities for environmental restoration of wildlife and aquatic habitat due to the degraded habitat in some locations, namely, Fourmile Creek and, Des Moines River.
- Reduction of maintenance costs, elimination of safety hazards and improved interior drainage need to be addressed.
- Structural alternatives for reducing flood damages in Des Moines are feasible and are likely to be economically justified.

4. B. FEASIBILITY STUDY PLAN FORMULATION

Following completion of the reconnaissance study, the District and the City entered into a feasibility cost sharing agreement in September 1999. The study was conducted as a partnership to identify opportunities for flood damage reduction within the City. This partnership approach was critical to successful completion of the study by improving coordination between the District, the City, the public, and numerous stakeholders.

The feasibility study was conducted in two phases: Phase 1 focused on gathering information about the five primary streams identified in the reconnaissance study as causing substantial flood damage within the City; Phase 2 consisted of analysis and evaluation of data. The following streams and watersheds were evaluated:

- Walnut Creek
- Fourmile Creek
- The Des Moines River

- The Raccoon River
- Leetown Creekway

The study team sought to develop/evaluate planning objectives and alternatives for a comprehensive flood damage reduction system in Des Moines. Systemic flood damage reduction alternatives from previous studies were reviewed and reevaluated to determine if any of these alternatives were effective and economically justified. No systemic alternatives such as storage reservoirs or channel modifications were found that appeared to be economically justified. A summary of measures eliminated from further analysis can be found in Table 6. Initially, it was believed that a uniform level of protection throughout the City would be most desirable. As the study progressed, however, it was found that different levels of protection were appropriate for each reach based on the economic benefits to the city and reduction of areas to flood fight. The plan formulation strategy evolved to one of developing optimum flood damage reduction alternatives for each reach that could be combined together into a coordinated flood damage reduction project.

The Phase 2 activities resulted in identification of the recommended plan for each reach. There was much overlap between the Phase 1 and Phase 2 activities since Phase 2 activities for each reach were started as soon as the Phase 1 information for that particular area became available (table 1).

Early coordination efforts with the City focused on identification of specific flooding problems and opportunities for ecosystem restoration and recreation:

Flood damage reduction efforts resulted in the identification of nine specific separable areas that had either experienced substantial flooding (such as Birdland Park, Central Place, and Fourmile Creek) or where substantial flood damages were possible (such as the Downtown levees). One area, the Des Moines River Levee between SE 6th and SE 14th Streets, was eliminated from further consideration because it was damaged in 2002 during a flood event and subsequently reconstructed to Federal Standards. Three, the Raccoon River Section 205 Project Levee (Reach 6), the Des Moines-West Des Moines Levee along the Raccoon River (Reach 8) and Leetown Creekway (Reach 11), were added for reevaluation following the finding that the Raccoon River flood discharges had increased. This resulted in eleven areas (reaches) being identified for inclusion in the study. A number of other areas were also considered for addition to the study, but were eliminated because of the very low potential for economic feasibility as a federal project.

Table 1: Inventory of Data Developed for the Study

Inventory	Location Evaluated Units
Digital topographic mapping from Aerial Services, Inc, Cedar Falls, Iowa at a scale of 1"=100' with 2' contour intervals Purpose: to give more accurate indications of areas that would flood and update flood insurance mapping	Approximately 16,500 acres
Levee elevation surveys performed by the City Des Moines Purpose: to provide data for alternative development for geotechnical design	Birdland Park and Central Place levees
Hydrologic modeling to determine estimated peak flood discharges, performed by the Rock Island District Purpose: to use the longest period of record and to examine increases due to urbanization	Fourmile Creek (The Des Moines and Raccoon had been published by HEC at Davis the year the study started)
Surveyed stream cross sections and bridge openings by the City Purpose: to provide more accurate input to HEC-RAS model for streams	352 cross sections & 50 bridges
Prepared digital hydraulic models of the Des Moines River, Raccoon River, Walnut Creek, Fourmile Creek, & Leetown Creekway to determine flood profiles, performed by the Rock Island District Purpose: to determine water surface elevation use for design and damages prevented	34.9 stream miles
Mapped floodplain, performed by the Rock Island District Purpose: to show inundation limits of 10, 25, 50, 100, 250, and 500-year flood events; use for city planning and possible update flood insurance study	Study Area
Detailed levee inspection including borings, performed by the Rock Island District and Terracon Consultants of Des Moines, Iowa Purpose: to determine condition of the levee and provide input to geotechnical design analysis	Study Area
Evaluation of habitat and specie by Rock Island District, USFWS, and the Iowa Department of Natural Resources (Iowa DNR) Purpose: to provide input to environmental impact analysis	Birdland Park, Central Place and Chichaqua mitigation site
Cultural Surveys, performed by Great Lakes Archeological Research Center Purpose: to determine the presence and significance of cultural sites	Chichaqua environmental mitigation site, Birdland Park, Central Place and downtown closures
Phase I Environmental Site Assessments, Stanley Consultants Inc. Purpose: to determine if there is a high probability of the presence of hazardous contamination in soil and ground water	Study Area
Phase IIA Environmental Site Assessments, Missman-Stanley and Assoc Purpose: to sample soil and ground water in suspected areas identified in Phase I site assessment	38 water samples 76 soil samples
Economic analysis of past and potential flood damage of structures and contents, performed by the Rock Island District Purpose: to provide information to develop B/C ratios	Study Area

Attempts to identify areas within the City for ecosystem restoration of wildlife and aquatic habitats were unsuccessful because of a lack of local financial support for sponsoring an ecosystem restoration project. There was no ecosystem restoration opportunity associated with flood damage reduction.

Recreational opportunities exist at all the levees due to the extensive trail system in the surrounding Des Moines area and will be evaluated with each reach that has a flood damage reduction project with a positive benefit to cost (B/C) ratio. More discussion of plan formulation can be found at each specific reach in this section.

a) Public Involvement

Throughout the feasibility study, the study team strived to inform, educate, and involve the many groups with an interest in the study. This coordination was paramount in assuring that all interested parties had an opportunity to be part of the study process. The public and interested agencies were involved in scoping, developing alternatives and reviewing products of this study. Affected landowners and other stakeholders continued to be part of the planning process as decisions were made.

The public involvement process was used to exchange information with various segments of the public in order to reduce unnecessary conflict and to achieve consensus. This public involvement and coordination helped to open and maintain channels of communication in order to consider public views and information in the planning process.

The public involvement plan for the study included the following techniques for providing information to the public and receiving feedback during the study: newsletters, study website, and a public open house. The newsletters provided study information and points of contact for the publics' questions and comments. The study website was created as a tool for additional information sharing. The open house was held in January 2003 to provide an opportunity for the public to meet one-on-one with study team members to discuss the study status and to offer comments. Additional information about the newsletters, website, and public open house is included in Appendix H.

4. C. ASSESSMENT OF WATER AND RELATED RESOURCES

The local watershed around the city of Des Moines was assessed as a system, which includes all of the previously described reaches, to determine if systemic flood damage reduction features, such as reservoirs, would contribute to more than one reach. The following existing conditions viewed from a systemic perspective helped the team to understand the interrelationships among the reaches. Additional assessments can be found in the appendices and in Section 6 of this report. Detailed conditions of each reach can be found in the reach-by-reach evaluations found in Sections 4.B. through 4.L.

4.C.1. General Existing Conditions

a) Flooding and Flood Protection

The annual precipitation for the region averages approximately 35 inches, with most of this falling as rain in the spring and summer months. Because of its location at the confluence of several streams, the City experiences frequent flooding. Hydrologic studies were conducted for the Des Moines River, Raccoon River, Walnut Creek, Fourmile Creek, and Leetown Creekway. These studies determined that the flood discharges for the Raccoon River and Des Moines River below the confluence with the Raccoon River were much higher than previously determined, but that the flood discharges in the Des Moines River above the confluence with the Raccoon River were about the same. The flood discharges for Fourmile Creek also showed a substantial increase. A summary of the updated flood discharges compared to the 1988 Flood Insurance Study (FIS) discharges and the estimated peak discharges from the 1993 flood is shown in the table below.

Digital topographic maps were developed using aerial photographs taken in 1996, 1997, and 2002. From the digital topographic maps and surveyed stream cross-sections, hydraulic models were prepared to compute water surface profiles and to develop floodplain maps for the above streams, and to update flood discharges. A summary of these hydrologic and hydraulic studies is included in Appendix A and Table 2.

Table 2: Flood Discharge Summary Cubic Feet per Second

River/Stream	1988 FIS 100-year	New 100-year	New 500-year	Peak 1993 Flood
Des Moines River, NW 2nd Avenue	33,000	37,000	52,000	55,000
Des Moines River, SE 14th Avenue	63,900	87,000	132,000	116,000
Raccoon River	46,300	61,300	85,900	71,000
Walnut Creek	17,000	15,900	24,300	6,460
Fourmile Creek	6,140	8,290	10,700	4,200
Leetown Creekway	1,304	1,585	1,880	-

The City has aggressively pursued flood protection, especially since the flooding in 1993. Reaches 6, 7, and 8 have been improved and a number of storm sewers and storm water detention basins have been constructed. New pump stations, reducing flooding from interior drainage, were constructed to federal standards along with other measures to reduce flood damages. In addition to construction activities, a total of $ 2,352,664 has been spent by the City in a voluntary home buyout program, resulting in the purchase of 26 homes in flood-prone locations. Even with these improvements, portions of the City remain vulnerable to flooding, particularly from larger flood events. Based on information gathered and evaluated in Phase 1 of the study, the following summary of existing flood protection shows that Birdland Park and Central Place do not provide the level of protection that was once thought, see Table 3.

Table 3: Flood Protection Provided by Existing Levees in Des Moines

Reach	Name	Federal or Nonfederal	Level of Protection
1	Birdland Park [1]	Nonfederal	Less than 10 year
2	Central Place [1]	Nonfederal	Less than 10 year
3	Downtown East [2]	Federal	Slightly more than 100 year
4	Downtown West [2]	Federal	Slightly more than 100 year
5	Downtown South [2]	Federal	Slightly more than 100 year
6	Des Moines Water Works [2]	Nonfederal	Slightly more than 250 year
7	205 Raccoon River Levee [2]	Federal	Slightly more than 100 year
8	West Des Moines Levee [2]	Federal	Slightly more than 100 year
9	Walnut Creek	No Levee	-
10	Fourmile Creek	No Levee	-
11	Leetown Creekway	No Levee	-

Note: In this table, the term *level of protection* is assumed to mean during a flood event that the levee would provide protection for "most" (95 percent) of, for example, 100-year flood events.
[1] Levees were evaluated to fail just above landside toe of levee thus reducing their previously thought level of protection.

In the downtown areas (Reaches 3, 4 and 5) that are currently protected by federal levees, the large number of closures that must be made reduces the level of protection. During flood-fighting events, the City must construct more than 26 street and railroad closures in the downtown levee systems, many of

which are constructed of sandbags. These numerous closures increase the risk of failure of the existing downtown flood protection system. In addition, the City must operate a large number of gatewells and pump stations to minimize damages from interior flooding. Because of the massive amount of labor and materials required to fight large flood events, heroic efforts are frequently necessary to protect the City.

The City utilizes an Automated Local Evaluation in Real Time (ALERT) flood warning system that provides City emergency personnel with advanced flood information via computer. Installed in 1990, the system is managed through an agreement among the cities of Des Moines, West Des Moines and Clive, and the National Weather Service (NWS). Currently, the ALERT system consists of 15 stream gages that measure water levels and rainfall rates. Sensors on the gages measure water levels and rainfall rates. The sensors are connected to data collection processors that transmit field data to the NWS base station. Transmission occurs via FM-line-of-sight radio signals or phone modem. The data is uploaded from the base station to a City of Des Moines server, where Des Moines, West Des Moines, Clive, and the NWS can access it. Software known as DiadVisor is used to monitor rising water elevations, rain gages, and gage status. Continued maintenance and updating of all the ALERT system equipment is imperative for the continued success of the flood warning system.

b) Recreation

The City has an extensive, well-used, recreational trail system. One of the primary trails in this system, the Neal Smith Trail, runs along the east bank of the Des Moines River through the downtown area (Reach 3) north and then on and adjacent to the Birdland Park levee (Reach 1). The trail system links many of the City's recreation facilities, including the Botanical Center, Sec Taylor Stadium, the Iowa Events Center, Gray's Lake, and Waterworks Park. Work is underway as part of the Greenbelt plan for additional recreation facilities in the downtown area and Greenbelt Region, covering nine counties. The City has developed a master plan for its recreational trails, which is found at http://www.ci.des-moines.ia.us/departments/PR/trails.htm. McHenry Park, a quarter mile from the Neal Smith recreational trail, is not connected. Residences in the Birdland Park community have requested that the City of Des Moines develop a hub connecting McHenry Park, Riverview Park and the Neal Smith Trail to provide a rest area and trail access.

c) Hazardous, Toxic, and Radioactive Waste (HTRW)

An environmental contamination baseline survey was performed consisting of two phases. A Phase I Environmental Site Assessment includes both a records search of ownership, land use, etc. and a walking site survey looking for evidence of soil or water contamination. A Phase IIA Environmental Site Assessment analyzes ground water and soil samples when contamination is suspected.

The Phase I assessment revealed that Reach 1 Birdland Park, Reach 2 Central Place, Reach 3 Downtown East, and Reach 4 Downtown West project areas included many commercial, light industrial and heavy industrial properties. A Phase IIA investigation was conducted for areas of environmental concern to assess the condition of soil and ground water. The HTRW assessment revealed recognized environmental conditions in the following locations: Birdland Park, Central Place (including the mitigation site), Downtown West, and Downtown East project areas. The HTRW assessment revealed no evidence of recognized environmental conditions, such as hazardous substances, HTRW , or other regulated contaminants in connection with the Walnut Creek project area, the Downtown South project area (Leetown Creek (the 7th Ward Ditch) project area, the Fourmile Creek project area, and the wetland mitigation site. The results are summarized in the evaluation of each reach and in Appendix E.

d) Environmental and Cultural Resources

The existing upland and bottomland forests on and adjacent to the existing levees have structural diversity such as snags, canopy cover, understory, and downed logs, indicative of habitat for a variety of species.

Emergent wetlands and open water lagoons within the project area also provide wildlife habitat and other functions and values including sediment and nutrient retention and bankline stabilization.

The U.S. Fish and Wildlife Service (USFWS) furnished a list (Table 4), of threatened and endangered species that may be found in the study area. Of the four species, suitable habitat only appears available for the bald eagle and Indiana bat.

Table 4: List of Federal Threatened and Endangered Species

Common Name	Classification	Habitat
Bald eagle	Threatened	Winters along major rivers and reservoirs
Western Prairie fringed orchid	Threatened	Wet Prairies
Prairie bush clover	Threatened	Dry Gravelly Prairie soils
Indiana bat	Endangered	Caves, mines, and small stream corridors with developed riparian woods; upland forests (foraging)

Any bald eagle roosting tree(s) would be avoided to the extent possible during preparation of plans and specifications; however, it is expected that the removal of one or a few roosting trees would have no appreciable adverse effect on the species. Tree clearing shall be limited to that which is absolutely necessary for construction of the project. There is also potential for suitable summer habitat for the Indiana bat within the wetland and upland forest project areas. Informal consultation between the USFWS and the District determined that a biological assessment would not be required for these species under the proposed project. If it is determined that one of the above species would be affected by any proposed project in this report, the appropriate actions would be taken according to Figure 23: Endangered Species Clearance Flowchart. No State-listed threatened or endangered species are known to be present in the project area. Environmental resource details can be found in the evaluation of each reach and in Section 6. A

The District queried the most current version of the District Archeological Site and Survey Geographic Information Systems (GIS) databases (current as of April 2004) and determined that there is one previously recorded archeological site within the project area. Reaches 1, 2, and 5 have not been surveyed previously and there are no previously recorded sites within the levee construction, closure construction, and/or wetland mitigation areas. Portions of Reaches 3 and 4 have been surveyed and one archeological site, 13PK61, is located in Reach 4, adjacent to a proposed railroad bridge closure structure.

The 19 proposed closure structures are located within the Civic Center Historic District: eleven closures in Reach 3, six closures in Reach 4, and two closures in Reach 5. The Civic Center Historic District is a National Register of Historic Places (NRHP) multiple property listing based on thematic areas of significance including architecture, community planning and development, and landscape architecture dating from 1892 to 1938. The nomination includes seven contributing structures, six contributing buildings, and five noncontributing structures. Two proposed levee closures are adjacent to the Court Avenue Bridge, a contributing resource to the NRHP Civic Center Historic District nomination, and two closures are proposed for the Des Moines Union Railway Bridge, a noncontributing structure that has been determined individually eligible for inclusion on the NRHP. Finally, four closures in Reach 4 are located within the recorded boundaries of NRHP eligible archeological site 13PK61. Site 13PK61, Fort Des Moines No. 2, is a multi-component prehistoric and historic archeological site. Numerous investigations have evaluated portions of the site and it was formally determined eligible for inclusion on the NRHP in 2000.

e) Social and Economic Conditions

The City, located in Polk County, is the state capitol of Iowa. The Des Moines River and Raccoon River trisect the City. In the year 2000, the City had a population of 198,700, while the Des Moines Metropolitan Statistical Area (MSA) has a year 2000 population of 483,000. Table 5 depicts historical and projected trends.

Table 5: Des Moines, Iowa MSA Population Trends

	1970	1980	1990	2000	2010
Population	364,700	392,800	418,000	483,000	534,000

The 2000 census data indicates that the Des Moines area labor force is concentrated in the service industries, wholesale/retail trade, and insurance/finance industries. Mean household income for year 2000 was $78,200 in the Des Moines area, compared to $65,600 for the State of Iowa, and $77,600 for the United States. Major state and federal highways, the Interstate Highway system, railway, and airline networks serve the metropolitan area.

In general, the existing condition floodplain in Des Moines is densely developed. Reach 4, Downtown West, has substantial growth and redevelopment. Since unprotected areas of the floodplain are regulated, at-risk structures are not expected to increase. The City has an ongoing floodplain property buyout program to purchase frequently damaged structures in unprotected areas. Further details regarding economic conditions can be found in Appendix B.

4.C.2. General Future Conditions without Project

Over the next 50 years, flood damage potential expressed as expected annual flood damages in certain study reaches would continue to adversely impact the City (Appendix B), and businesses and residences would continue to be vulnerable to flooding. Recreational needs would continue to increase according to City trends and increase in population. Hazardous contamination is not likely to change in the near future. Environmental habitats would continue to mature, agricultural land uses would slowly be urbanized, and the population of the metropolitan area is likely to expand to 650,000.

4.C.3. Summary of Problems and Opportunities

Following is a summary of specific problems and opportunities identified as part of this study. The study objectives are to identify optimized alternatives that solve these specific problems and take advantage of the opportunities when possible.

Specific Reach	Problem/Opportunity
Reaches 1 & 2, Birdland Park and Central Place levees	Existing levees do not provide reliable flood protection. Are there cost-effective measures to reduce potential flood damages?
Reaches 3, 4 & 5 Downtown levee systems closures	Numerous closures decrease the reliability of current flood protection systems. Will increases in flood protection height and redesign of closures be cost effective?
Reaches 6, 7, 8 Other levee systems, Raccoon River 205, Water treatment plant and West Des Moines	Flooding can occur above the 100-year level. Are there flood damage alternatives that are cost effective?
Reaches 9, 10 and 11, Walnut Creek, Fourmile Creek and Leetown Creekway	No flood protection exists and the areas are subject to frequent flooding. Are there any cost effective measures to reduce damages?

4.C.4. Planning Constraints

The planning constraints identified for this study were requirements that the plan alternatives be economically and environmentally feasible and qualify for federal interest under existing laws. Further, plan formulation must provide safe conditions in the interest of public safety and be socially acceptable to the community. Increased urbanization has led to higher land values and is encroaching on possible reservoir sites.

4.C.5. Description of Initial Measures Eliminated from Further Analysis

The *"Des Moines River Basin, Iowa and Minnesota Feasibility Study" dated July 22, 1977* was reevaluated using updated hydrology to determine if any conditions had changed that would make constructing reservoirs, dry dams or other water retention or channel widening features economically feasible. The following projects were briefly reconsidered during this study:

- Constructing reservoirs in the Raccoon River and Walnut Creek watersheds
- Channel and bridge modifications on Raccoon River and Walnut Creek

In addition, constructing a reservoir on Fourmile Creek was considered. The following table summarizes measures eliminated from further analysis in the study. Table 6 provides a more detailed description.

Table 6: Summary of Measure Eliminated from Further Analysis

Measure	Reason for Elimination
Reservoirs	1. The Des Moines River has two large reservoirs up and down stream of the City 2. Much of the watershed is flat with development in remotely suitable areas
Channel Modification By-Pass Channels	1. The Des Moines River contains two dams; increasing the cross-sectional area by deepening the channel is not possible. 2. Existing levees flank both banks; increasing the cross-section by widening the cross-section would mean condemning downtown real estate and rebuilding the levees. 3. Environmental mitigation would be required and would be cost prohibitive.
Non Structural measures Flood Warning Buy-out program	1. Flood warning system already exists 2. Flood proofing is cost prohibitive because of the large numbers of properties in Reaches 1-11. 3. Reaches 1-8 already have some type of flood control and are heavily populated; buy-out measures are not feasible. Reaches 9 & 10 have a low number of affected structures and lower flood damages that do not warrant a buy-out program. Reach 10 was the only reach with a possibility of having economic justification for a buy-out program, as discussed in Section 4. N.
Ecosystem Restoration	No opportunities were found to combine ecosystem restoration with viable flood damage reduction measures.

The following is a description of the measures eliminated from further evaluation:

a) Constructing Reservoirs

This type of flood damage reduction measure generally requires a large site and topography such that water can be stored in the area without inducing damages on nearby property. There are already two reservoirs on the Des Moines River, upstream of the city is Saylorville reservoir and downstream from the city is Red Rock reservoir. Based on a reevaluation of previous studies on the Des Moines River,

building additional reservoirs and modifications to the existing reservoirs were again eliminated from further consideration. Saylorville reservoir currently provides substantial flood damage reduction benefits; modification of the dam to further increase storage is not feasible.

Reservoirs have been widely proposed as a solution to reduce flooding in Fourmile Creek. An upstream reservoir sites identified in the USACE May 1975 study determined that reservoirs were not cost effective and presently are no longer available due to industrial development adjacent to Fourmile Creek in the Ankeny area. Additional reservoir sites in the Fourmile Creek watershed are not available due to the relative flat topography in northern Polk County and southern Story County. A relatively large site would be needed to store enough runoff to effectively reduce flooding. A reservoir to reduce the discharge of a 1 percent annual chance (100-year) flood to that of a 10 percent annual chance (10-year) flood would need approximately 6,600 acre-feet of storage. If such a site were available, this reservoir would cover 660 acres to an average depth of 10 feet.

The City has very successfully reduced flooding through the development of stormwater detention basins in the Leetown Creekway watershed. Very little potential for additional detention basin development is available within the heavily developed watershed.

Reservoirs in the Raccoon River watershed, which includes Walnut Creek, were also eliminated in the USACE 1975 Des Moines River Basin report and confirmed in this study. The report concluded; "Upstream reservoirs would have to be supplemented by other resources at the Wes Des Moines / Des Moines area because the dam sites are too far upstream of the area to effect significant reductions in the flood profiles." No reservoir sites are available that warrant further consideration for providing flood damage reduction to the City of Des Moines metropolitan area.

b) Channel modifications and bypass channels

Channel modifications to increase the stream channel's capacity to carry flood flows, such as enlarging, straightening, and smoothing stream channels and removing channel obstructions, such as log jams and bridge piers, is rarely viable. As one control point is removed, another either exists or is created downstream which causes water to back up. Alluvial sand, soil, and rock deposited by the river removed to enlarge or deepen the channel would be replaced in time, requiring constant maintenance, which is expensive. Environmental habitat is nearly always disrupted, causing channel modification to be expensive for little long-term benefit. The USACE 1975 Des Moines Basin Report found no cost-effective channel modifications, the most feasible measures having preliminary benefit-to-cost ratios of less than 0.1. During this planning effort, new floodwater profiles of the existing channel were developed. No measures were identified that would cost-effectively reduce flood damages; therefore channel modification was eliminated from further analysis. Bypass channels were identified as infeasible and were eliminated from further analysis.

c) Non-structural measures

Nonstructural measures reduce flood damages without significantly altering the nature or extent of flooding, either by changing the use made of the floodplains or by accommodating existing uses to the flood hazard. Some examples of nonstructural measures include flood proofing; modifying or elevating structures to minimize flood damages; permanent evacuation of structures; flood warning/preparedness systems; and regulation of floodplain uses. Reaches one through eight have levees and are heavily populated; non-structural measures would not be cost effective due to the number of structures. Reaches nine through eleven have no economically feasible non-structural measures.

Flood damage along portions of Walnut Creek is not severe enough to economically justify a buy-out program nor is it acceptable to the city. Flood proofing of selected individual structures is likely a cost-effective solution, but was not considered for implementation as a federal project for any of these three reaches. Reach 10-Fourmile Creek's floodplain is currently in a buy-out program and many of the

structures have been removed. Several homes and a mobile home park, which had the most frequent and highest damages, were evaluated and found to have B/C ratios less than 0.35 (see the evaluation of Reach 10-Fourmile Creek starting on page 58). Continued buy-outs of flood-prone structures is encouraged.

The City of Des Moines' "ALERT" flood warning system is in place and is providing nearly real time data to city emergency management. The City continues to improve and update this system as needed. Major improvements to the system are unlikely to substantially reduce damages and were eliminated from further evaluation.

d) Ecosystem Restoration Opportunities

Due to the existing urban land uses, relatively high property values, and city funding priorities, no ecosystem restoration opportunities would be utilized and is therefore eliminated from further analysis.

4.C.6. Description of Available Measures for Individual Reaches

Only two flood damage reduction measures are still available for evaluation, buy-out program and the construction of levees. The buy-out program has already discussed, however a levee system has not until now. The term levee includes levees, floodwalls, dikes, associated drainage structures, ponding areas, pump stations, and closure structures. For Reaches 1 through 11 new levees could be constructed to protect areas without flood protection, and existing levees could be reconstructed or modified to provide an improved level of protection.

4. D. REACH EVALUATION SUMMARY

A summary of economic findings is presented in Table 7.

Table 7: Economic Summary, highlighted preferred plan (May 2004 price level)

Reach and Plan	Top of Levee	Project Cost Estimate	Interest During Const.	Total First Costs	Annualized First Costs	Annual O & M Costs	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits	Residual Flood Damages
Reach 1 Birdland Park Study Area											
Alignment 1											
500 year		6,679,000	575,000	7,254,000	436,000	14,000	450,000	437,000	0.97	-13,000	11,000
Alignment 2											
100 year	803.3	3,618,000	343,000	3,961,000	238,000	14,000	252,000	255,000	1	3,000	181,000
250 year	806.3	4,048,000	372,000	4,421,000	266,000	14,000	279,000	312,000	1.1	32,000	130,000
500 year	809.5	4,984,000	437,000	5,421,000	326,000	14,000	340,000	437,000	1.3	97,000	11,000
Alignment 3											
500 year		6,434,000	506,000	6,940,000	417,000	14,000	431,000	437,000	1	6,000	11,000
Reach 2 Central Place Study Area											
100 year	802.3	3,156,000	240,000	3,396,000	204,000	15,000	219,000	667,000	3.1	448,000	235,000
250 year	805.3	3,420,000	258,000	3,678,000	221,000	15,000	236,000	764,000	3.2	528,000	139,000
500 year	808.7	3,839,000	287,000	4,126,000	248,000	15,000	263,000	895,000	3.4	632,000	8,000
Reach 3 Downtown East Levee											
Closure Improvements		642,000	37,000	679,000	41,000	0	41,000	156,000	3.8	115,000	252,000
500 year levee		11,440,000	1,070,000	12,510,000	752,000	10,000	762,000	113,000	0.2	-649,000	
Reach 4 Downtown West Levee											
Closure Improvements		260,000	15,000	275,000	17,000	0	17,000	74,000	4.5	57,000	160,000
500 year levee		4,943,000	529,000	5,472,000	329,000	10,000	339,000	97,000	0.3	-241,000	
Reach 5 Downtown South Levee											
Closure Improvements		31,000	2,000	33,000	2,000	0	2,000	30,000	15.3	28,000	46,000
500 year levee		6,175,000	577,000	6,752,000	406,000	10,000	416,000	29,000	0.1	-388,000	
Reach 6 Raccoon River Section 205 Levee											
Plan 1 Evaluate reliability of existing Federal levee. Levee improvement plans were eliminated during plan formulation.											
Reach 7 Des Moines Water Works Levee											
Plan 1 Evaluate reliability of existing Federal levee. Levee improvement plans were eliminated during plan formulation.											
Reach 8 Des Moines-West Des Moines Levee											
Plan 1 Evaluate reliability of existing Federal levee. Levee improvement plans were eliminated during plan formulation.											
Reach 9 Walnut Creek at Grand Avenue											
Plan 1		2,481,000	143,000	2,624,000	158,000	0	158,000	50,200	0.32	-108,000	
Reach 10 Fourmile Creek											
Plan 1 MH Park Buyout		2,150,000	124,000	2,274,000	137,000	0	137,000	47,000	0.35	-89,000	
Plan 2a Levee LB-2		3,790,000	213,000	4,003,000	241,000	3,000	244,000	13,000	0.06	-230,000	
Plan 2b Levee LB4		2,690,000	151,000	2,841,000	171,000	3,000	174,000	12,000	0.07	-162,000	
Plan 2c Levee RB3		571,000	32,000	603,000	36,000	1,000	37,000	1,000	0.03	-36,000	
Plan 2d Levee RB4 & RB5		1,420,000	80,000	1,500,000	90,000	2,000	92,000	0	0	-92,000	
Plan 2e Levee RB6		165,000	9,000	174,000	10,000	1,000	11,000	1,000	0.1	-10,000	
Reach 11 Leetown Creek											
Plan 1 Evaluate reliability of the Red Rock Remedial Works levee (see Plan Formulation Section and Hydraulics Appendix). Evaluation reported adequate reliabilities, therefore no Leetown Creekway structural improvements were assessed.											

5-5/8% Discount Rate, 50-Year Evaluation Period

4. E. REACH 1 - BIRDLAND PARK EVALUATION

The Birdland Park area contains 170 acres of residential and commercial property located along the left descending bank of the Des Moines River north of the downtown area. This area includes the North High

School complex, Birdland City Park, and numerous commercial establishments. This levee was overtopped during the 1993 flood, causing extensive flood damages. This levee requires upgrading to meet current USACE flood protection levee standards. A comprehensive analysis of levee height and structure was conducted, along with street closures and other related structures (Figure 3.)

4.E.1. Existing Conditions (Birdland Park)

Based on the revised hydrologic and hydraulic modeling discussed in Volume 2, Appendix A, the updated 100-year flood profile of the Des Moines River at Birdland Park was determined to be essentially the same as the 1988 flood insurance study (FIS) report. The Birdland Park levee, constructed in the 1950s by the City, was overtopped during the 1993 flood event, causing extensive damage. The levee was constructed of miscellaneous fill and has been found to contain rubble and debris. Today, the top width and slopes are variable and do not meet minimum federal standards. In the years since construction, portions of the levee have become heavily overgrown with trees. Geotechnical analysis of the levee has determined that this levee is insufficient to provide reliable flood protection. The existing levee has the following estimated probabilities for failure, based on water surface elevation National Geodetic Vertical Datum (NGVD):

- 801.0 feet NGVD – Above the 100-year flood event - (95% probability of failure)
- 798.0 feet NGVD - Below the 50-year flood event - (50% probability of failure)
- 784.0 feet NGVD - Below the 5-year flood event - (0% probability of failure)

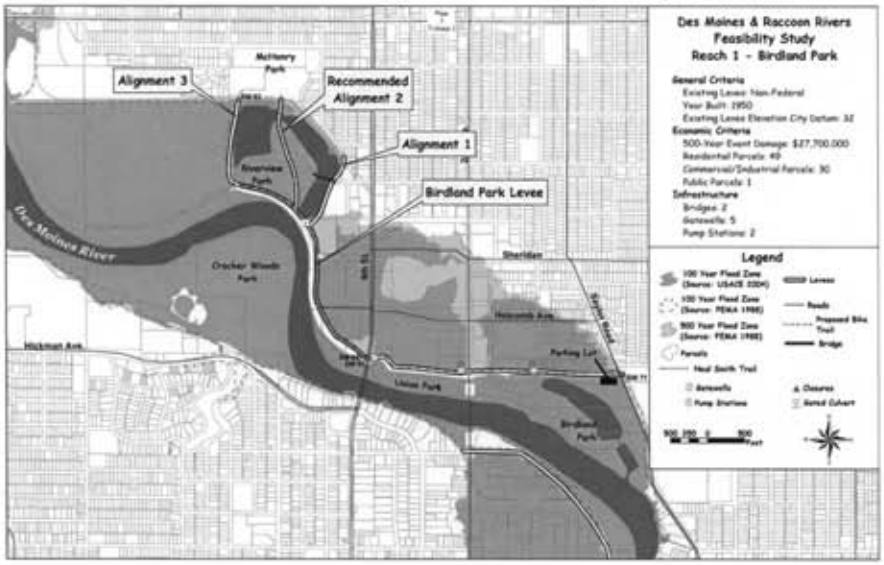

Figure 3: Reach 1 Birdland Park Study Area

The soils underlying the proposed levee through the Riverview Park include sand seams. The sand layers could contribute to under-seepage.

Storm water systems do not cross-over into Reach 3 Downtown East, making Reach 1 independent. Two pump stations, one built in the late 1960s, is next to Guthrie Avenue, and the other, constructed in the 1990s, is west of 2nd Avenue. Both pump stations are well maintained and provide adequate protection from interior flooding. The road closure opening at Saylor Road is over 150 feet wide and over 6 feet high, making it too large to be effectively closed with temporary earthen structures during flood events. FEMA's Flood Insurance Rate Maps (FIRMs) currently show the Birdland Park levee as providing 100-year flood protection; however, based on the findings for this study, the existing levee does not meet federal standards for providing 100-year flood protection, see Appendix C, Engineering.

The Birdland Levee is currently part of the City of Des Moines recreational trail system, the Neal Smith Trail. This trail runs beside and on the top of the levee, and is a segment of the longer Saylorville Trail (Figure 4). The Neal Smith Trail runs north from University Avenue to the City limits along the Des Moines River to Saylorville Lake, and then to Big Creek State Park. Trailheads are located at the Botanical Center's riverfront parking lot near the University Avenue Bridge and at a shopping center off Douglas Avenue. The existing recreational trail is on and alongside the levee at Birdland Park and is well used.

Figure 4: Neal Smith Trail, Woody Vegetation on Levee

Hazardous, toxic, or radioactive waste (HTRW) soil testing indicated the presence of arsenic, beryllium, and benzo(a)pyrene. Groundwater testing confirmed the presence of arsenic, beryllium, thallium, barium, boron, cadmium, chromium, lead, manganese, nickel, selenium, and vanadium. Contaminant concentrations were in excess of the Iowa Land Recycling Program statewide standards. HTRW

clearance has been obtained from the State of Iowa in a letter dated 7 February 2005 and is located in Appendix H.

The structural diversity of the existing large trees, shrubs, and herbaceous plants growing on the levee provide habitat for a variety of wildlife. A bottomland hardwood forest of varying widths and distances to the Des Moines River borders the riverward side of the levee.

The Kiwanis Club leases Riverview Park from the City, and has developed a Master Plan for replacing an abandoned amusement park with a more natural setting for public recreation. Possible recreational improvements are also proposed as part of the Greenbelt; however, planning for these improvements is currently inactive. Riverview Park has scattered large trees, although most of the island is mowed by the Kiwanis Club to maintain a park-like setting. A cattail marsh in the western end of the island sits on an abandoned asphalt parking lot, and a scrub-shrub and emergent wetland runs along the northern tip of the island increases the value of the area for wildlife and recreation. The large bottomland hardwood forest that runs along the levee continues along the western edge of Riverview Park and the adjacent large lagoons. The lagoons are fed by groundwater and storm water and do not have a surface water connection to the Des Moines River. Sediment is being carried into the lagoons in excess amounts due to erosion around the storm water culverts at the northern end of the lagoons. Local recreational fishermen utilize the lagoons. South of Riverview Park, the landward side of the existing levee is developed with mowed lawns and paved roads. The riverside of the existing levee is primarily vegetated with emergent wetland species, see Section 4.E.6.a) of this report for additional environmental information.

A cultural survey and record investigation recommended cultural resource management clearance for the entire Reach 1 study area.

It is likely that large flood events of the magnitude of the 1993 flood would not be successfully fought, and flood damage to the existing structures would exceed 50 percent of their value. Those structures would then need to be demolished or relocated from the floodplain, and reconstruction on that site would be allowed only if certain costly design features were included in the reconstruction design. As this progressively occurs over time, many existing neighborhoods would become vacant lots and/or degraded housing. It is also likely that future development of Birdland Park would occur on lands that are outside the floodplain, creating further problems in the older established neighborhoods. There would also be restrictions on the development of structures located in the floodplain, consistent with the National Flood Insurance Program. The ongoing cost of flood insurance and the spiral of negative impacts associated with the community located within the regulatory floodplain remaining susceptible to flooding are unacceptable to City officials.

4.E.2. Future without Project Conditions (Birdland Park)

The existing Neal Smith Trail, which is adjacent to and on top of the existing levee, would likely be broken apart in areas where the levee fails. Existing hazardous contamination would remain undisturbed until the levee failed, at which point it may be released into the environment. The North High School facilities would remain at risk to flood damage and extended school closures.

"No Action" means that no federal flood reduction project would be constructed. This alternative assumes that the community would continue to rely on the existing levee system, emergency flood fighting measures, and flood insurance to provide flood damage protection.

4.E.3. Problems and Opportunities (Birdland Park)

Problem: The existing levee has a high probability of failure due to instability of the levee embankment, putting nearly 200 homes and businesses at risk of flooding. Fifty-year-old trees and brush, unsuitable construction materials, and steep embankments which are difficult to mow to keep vegetation controlled

are the major sources of instability. Inability to adequately make road closures during floods also increases the potential for flood damage.

Opportunities: There is an opportunity to improve a portion of the Neal Smith Trail by widening it to improve safety and to accommodate increased recreational traffic. The City would like to connect McHenry and Riverview Parks with the Neal Smith Trail. With these improvements, it is estimated that a 75-100 additional people would use the trail daily. As earlier stated, residents of the Birdland Park community have requested that the City of Des Moines develop a hub connecting McHenry Park, Riverview Park and the Neal Smith Trail to provide a rest area and trail access.

4.E.4. Measures Eliminated From Further Analysis (Birdland Park)

Reconstructing the existing levee to protect against a 25-year or 50-year flood were eliminated because these heights would result in a levee that is lower than the existing levee, and would require removing earthen material from the site, which would result in a cost greater than flood damage reduction benefits.

4.E.5. Selecting and Combining Measures into Alternatives (Birdland Park)

Stanley Consultants, with the aid of study team members, investigated the reliability of the existing levee system by making soil borings. Based on the results of the study, the study team's conceptual plan was to:

- remove all woody vegetation from the levee and 15 feet outside the toe;
- dig an inspection trench 8-feet wide along the bottom of the levee to determine the types and locations of unsuitable construction materials in the levee;
- rebuild the levee and replace those materials with suitable core material. In the southern portion of the proposed levee rebuild, portions of the Neal Smith trail are on top of the levee and only 9-feet wide. The reconstructed levee would be widened to accommodate a 12-foot trail, and.
- Construct a seepage berm on the land side of the levee to ensure control of seepage in areas where the ground elevation is less than 32 feet city datum.

The Stanley team determined that there were three viable alternative alignments as shown in Figure 5 , varied environmental, real estate acquisition and cost impacts to the project. All alignments will be initially compared at the 500-year levee height. The following description of each alignment:

Figure 5: Birdland Park Proposed Levee Alignments

Alignment 1 hugs the easterly shore of the lagoon, tying off into the bluff at the nearest point beyond the commercial buildings and is constructed of both floodwall and levee. A floodwall is required to avoid affecting the existing businesses. The advantages of this alignment include minimizing impacts to wetlands/bottomland hardwood forest. However, real estate/land acquisition costs are the highest for this alignment because of the close proximity to commercial businesses.

Alignment 2 crosses Riverview Park and avoids the already-cramped access to the commercial buildings. It is an earthen levee and has 42" Reinforced Concrete Pipe (RCP) drainage pipe and gatewell to drain the eastern portion of Riverview Park Lagoon. A seepage berm would be constructed on the island, with any open water or wetlands filled in to insure proper operations. It also disturbs twice the amount of wetland acres as Alignment 1. A recreational feature would include a bicycle trail/hub connecting the existing Neal Smith Trail, to McHenry Park and Riverview Park. Landscaped overburdens with a pedestrian and bike trail down to Riverview Park with overlooks and resting areas would act as a hub to the two parks and Neal Smith Trail system (Figure 6).

Figure 6: Recreational Features at Riverview Park Associated with Alignment 2

Alignment 3 follows the existing alignment and is an earthen levee with a seepage berm. A 42" RCP drainage pipe and gatewell drains storm water from the lagoon. In addition, this alignment would include a bicycle trail connecting the existing Neal Smith Trail to McHenry Park. Alignment 3 removes three times the amount of wetland/bottomland hardwood forest acres but avoids impacts to Riverview Park.

Each of these three alignments shares a common portion of proposed levee reconstruction, portions of which would accommodate the improved Neal Smith recreational trail. Along with other portions of the levee, the levee slopes would be truncated by retaining walls to avoid affecting existing parking lots and ball fields. A double-gated closure would be constructed at Saylor Road as part of the levee design. Following USACE regulations to account for the risk and uncertainty in a design, a detailed process was undertaken to determine the top of levee elevation relative to the design water surface elevation. A confidence interval was established around the various design parameters, and a quantitative analysis is performed to assure that the elevation at the top of the levee has a high probability of containing the design flood event. In addition, a 0.9 foot superiority elevation was added upstream to assure that any overtopping event occurs first at the downstream end of the project. Cost estimates were developed for three different levee heights (100-, 250- and 500-year) and were evaluated to see which optimized the economic benefits. Table 8 summarizes the features included in each of the three alternative alignments.

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Table 8: Summary of Flood Protection Alternatives

Alignment 1
Flood Protection Features: • Levee length: 7,000 ft; side slope is 3 to 1 with a 10' to 15' crown width • Flood wall instead of levee along east portion Riverview Park Lagoon • Closures at Saylor Road, 2nd Ave and 6th Ave • Retaining wall to narrow levee footprint at Birdland Park's parking area • Replace existing bike trail *Recreation Features:* • Widen Neal Smith bike trail to 10'
Alignment 2
Flood Protection Features: • Levee length: 7,700 ft, side slope is 3 to 1 with a 10' to 15' crown width • Seepage berm, land side of the levee 150' from toe of levee • Closures at Saylor Road, 2nd Ave and 6th Ave • Retaining wall to narrow levee footprint at Birdland Park's parking area • Replace existing bike trail • 42" RCP Drainage pipe and gatewell for Riverview Park Lagoon *Recreation Features* • Widen Neal Smith bike trail to 10' • Bike trail on levee with access to Riverview Park and McHenry Park • Over burden and landscaping
Alignment 3
Flood Protection Features: • Levee length: 8,300 ft, side slope is 3 to 1 with a 10' to 15' crown width • Seepage berm, land side of the levee 150' from toe of levee • Closures at Saylor Road, 2nd Ave and 6th Ave • Retaining wall to narrow levee footprint at Birdland Park's parking area • Replace existing bike trail

- 42" RCP Drainage pipe and gatewell for Riverview Park Lagoon

Recreation Features

- Widen Neal Smith bike trail to 10'

a) Borrow Material

The Birdland levee project would require more than 100,000 cubic yards of compacted impermeable borrow. Searching for a suitable borrow site took a significant amount of time. The initial site proposed was a 50-acre area in the floodplain north of Euclid Avenue on the west side of the river, owned by USACE and managed by the Polk County Conservation District. The proposal was to develop topographic diversity to improve the existing wetlands found in the area. After coordination with local, state, and federal agencies, the District decided not to use the site. Using aerial photography, open agricultural fields that could possibly be used for borrow material were identified. None of these sites were selected because the suitable sites were private property and a long distance from the project. Finally, the City recommended using the excess material excavated from the I-235 project for borrow. The District geotechnical engineering section reviewed the boring logs for this material and determined the material suitable for the levee project. The City arranged to have the material stockpiled at the Harriet Street landfill area, approximately 5miles from the project site. Missman Stanley Phase IIA soils analysis has confirmed the presence of arsenic and beryllium in the stockpiled borrows material that is in excess of the Iowa State Land Recycling Program standards. Remediation may be required as coordinated with the Iowa State Land Recycling Program. Hazardous, toxic, or radioactive waste (HTRW) soil testing confirmed the presence of arsenic, beryllium in excess of the Iowa Land Recycling Program statewide standards. HTRW clearance has been obtained from the State of Iowa in a letter dated 7 February 2005 and is located in Appendix H.

In addition to the primary flood damage reduction features of the project, recreational features have been integrated into the project design at the request of the City. These recreational features include widening part of the Neal Smith recreational trail system on top of the proposed Birdland Park Levee and developing a trail on the proposed Alignment 2 levee from the Neal Smith Trail across Riverview Park to McHenry Park. A trail leading down off the levee crossing Riverview Park would be constructed on both sides of the levee, reconnecting two parts of Riverview Park that were divided by the original levee. Some recreational lookouts constructed on overburden added at the top of the levee are also proposed for this area for enhancing the park's use.

4.E.6. Screening of Alternatives (Birdland Park)

a) Environmental Impacts

An interagency team comprised of the District, USFWS, and Iowa Department of Natural Resources (Iowa DNR), evaluated the project area and conducted a habitat analysis to quantify the forested habitat impacts and develop appropriate mitigation measures to offset those impacts. Informal consultation between the USFWS and the District determined that a biological assessment would not be required for these species under the proposed project.

The habitat analysis of existing study area conditions, future conditions without the project, and the compensatory mitigation proposal used a modified version of the numerical habitat appraisal methodology, Expert Habitat Evaluation Technique (EXHEP). Impacts for all alternatives are shown in Table 9, with Alignment 2 showing a range of impacts depending upon final design.

Mitigation acreage may exceed the number of acres impacted depending on the habitat functions of the impacted area and the proposed mitigation site. The acreages shown in Table 9 reflect the most current plan. These acreages are different than those stated in the Fish and Wildlife Coordination Act Report as

shown in Appendix H because the plans have changed slightly since the Coordination Act Report was prepared. Ongoing coordination has taken place with FWS regarding these plan changes to ensure they have had the opportunity to provide input as the District finalizes the proposed alignments.

Habitat analysis suggests that Alignment 3 would have the greatest impacts to upland and bottomland forest followed by Alignment 2. Alignment 1 would impact the least amount of possible threatened and endangered species habitat.

Table 9: Comparison of Environmental Impacts at Birdland Park Levee

Alternatives	100-year levee					250-year levee					500-year levee				
	Wetland [1]	Bottomland Forest [2]	Open Water	Upland Forest	Total Acres	Wetland	Bottomland Forest	Open Water	Upland Forest	Total Acres	Wetland	Bottomland Forest	Open Water	Upland Forest	Total Acres
Alignment 1	0.2	0.2	0.1	1.4	1.9	0.3	0.2	0.1	1.4	2.0	0.5	0.2	0.1	1.4	2.2
Alignment 2	1.0	0.2	2.4	1.4	5	1.2	0.2	2.5	1.4	5.3	1.4	0.2	2.7	1.4	5.7
Align. 2 max.											2.3	0.2	3.8	1.4	7.7
Alignment 3	2.9	0.9	2.2	4.3	10.3	3.3	0.9	2.4	4.3	10.9	4.0	0.9	2.7	4.3	11.9
No Action	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[1] Acreage refers to emergent wetlands impacted through permanent filling from levee placement
[2] Acreage refers to loss of bottomland forest within 15 feet of the proposed levee alignment

b) Mitigation site in the Chichaqua Bottoms Greenbelt

"The Skunk River was straightened many years ago, but the river's old floodplain remains wet and easily flooded. For decades, various conservation partners have created and expanded the Chichaqua Greenbelt floodplain, setting it aside for a variety of wildlife and recreation purposes.

Chichaqua is an important resting and staging area for migrating waterfowl and is home to several rare and declining species. It's also home to many reptiles and amphibians, as well as ground-nesting birds like the bobolink. Other parts of the wildlife area contain native prairies, natural or restored wetlands, and trails. Recreational uses include hunting, trapping, native seed harvest, future native seeding, educational tours, hiking and camping" *Iowa Natural Heritage Foundation*

Although this mitigation site is not in the immediate vicinity of the impacts, this 85-acre of farmed land near Hubbell Road, owned by the City was chosen to replace habitat lost at the Birdland Park levee construction. Located within the larger Chichaqua Bottoms Greenbelt, which is approximately 7,000-acres of marshes, forests, prairies, and oxbows that is slowly being restored by a multi-agency effort led by the Polk County Conservation Board, this 20-acre mitigation site is adjacent to another mitigation effort that has installed monitoring wells and has over five-year of monitoring data. This data would be used to aid in designing the new habitat structure. As stated before, the Chichaqua mitigation site is currently used for row-crop agriculture, except for the portion already developed into a wetland (Figure 7). Loss of this marginal farmland would not have any significant impacts to agriculture business. The No Action alternative would allow continued agricultural use of the site for the immediate future.

However, because the site was purchased for mitigation purposes, conversion of the entire site into wetlands would eventually take place. A summary of alternative mitigation plans are described in Table 10 Birdland Park Alternative Mitigation Incremental Cost Comparison.

Figure 7: Chichaqua Proposed Wetland Mitigation Site

Table 10 Birdland Park Alternative Mitigation Incremental Cost Comparison

Description of Mitigation Alternative	Cost
Mitigation avoidance would set back the levee into an urban setting along Alignment 1; condemnation would be required for the entire length of the levee affecting homes, schools and commercial buildings.	$1 million plus makes the project economically unbeneficial
Onsite mitigation would require condemnation of adjacent City Parks, (politically unacceptable)	N/A
Another offsite mitigation alternative is a city owned area in close proximity to the Des Moines River and soccer fields. The site is located on the hillside above Euclid Ave. Above the site lies high-density housing which may pollute the stormwater runoff supplying the site. Because of the urban setting, there is a high likelihood that pollutants would affect the wetland's function. The site would also require significant physical modification to provide structure, and top soils to replace the lost habitat functions.	$600,000 plus, a high construction cost and low ecological suitability of this site excludes it from further evaluation.
Offsite conversion of farmland in the Chichaqua Bottoms Greenbelt floodplain.	$300,000 (most cost effective plan)

A cultural survey and record investigation documented one isolated archeological site of unknown prehistoric affiliation at the mitigation site and a recommendation was made to make it ineligible for inclusion to the National Register for Historic Properties. The State Historic Preservation Officer concurred with this recommendation. No hazardous contamination concerns were indicated from Phase 1 records search and site survey.

Overall, social and environmental impacts shown in Table 11 were weighted by the number of arrows. Arrows pointing up are positive, arrows pointing down negative. This table provided a summary of impacts for each alignment. Wetland and other environmental impacts were considered during the screening of alternative alignments. The level of environmental impacts and low net annual benefits caused Alignment 3 to be screened out early in the process. Alignment 1 has the least amount of environmental impacts, although it was determined to not be a practicable alternative due to its even lower net annual benefits.

Table 11: Birdland Park Summary of Environmental Quality Account and Project Objectives

Impacts to	No Action	Alignment 1	Alignment 2	Alignment 3
Social-Economic Build Levee	↓↓↓↓	↑	↑	↑
Wildlife Habitat	↑	↓	↓↓	↓↓↓
Kiwanis Club Aesthetics	↑	↓	↓↓	↑
Recreational Opportunities Trail to McHenry Park	↑	↓	↑	↑
Continuity of the Neal Smith Trail	↓	↓	↑	↑

Note: categories that had variance across alternatives were chosen

Table 12 identifies construction costs for each of the alternative alignments, and shows how mitigation and Real Estate (LERRD) costs varied over the alignments. Alignment 2 incurs the lowest over-all construction costs. To simplify the comparison, only the 500-year levee height was evaluated. Each of the lower levee heights showed similar proportions among the three alignments.

Table 12: Construction Cost Break-out for Alternative Alignments, Birdland Park

Alignments (500-year)	Construction	LERRD	Environmental Mitigation	Total for Comparison	Compared Difference
Alignment 1	**$5,674,000**	**$870,000**	**$60,000**	**$6,604,000**	**$1,637,000**
Alignment 2	**$4,172,000**	**$655,000**	**$140,000**	**$4,967,000**	**$0**
Alignment 3	**$5,185,000**	**$520,000**	**$350,000**	**$6,055,000**	**$1,088,000**

These cost figures were preliminary estimates and were used in the initial screening process.

Alignment 2 is the recommended alternative because it has the highest net annual benefits. In addition, wetland and other environmental impacts would be avoided and minimized to the extent possible. A compensatory mitigation plan has also been developed to compensate for any unavoidable wetland and upland forest impacts associated with Alignment 2.

When it became evident that Alignment 2 would be the recommended plan, several coordination meetings were held with the Kiwanis Club to discuss impacts to their plans for Riverview Park, including alternate levee alignments on Riverview Park. Representatives of the Kiwanis Club identified the following planning limitations:

- save as many of the large trees on the island as possible
- minimize impacts to wetlands
- provide access to both sides of the levee with a trail system
- develop landscaped overburdens to naturalize the levee
- provide overlooks and minimize maintenance

In addition, the District identified the following constraint: An alignment on the eastern shore of the island would locate the seepage berm next to the lagoon. During flood events, inspection of the levee system would be difficult.

It was agreed that during plans and specification development, coordination with the Kiwanis Club and the Des Moines City Parks Department would be necessary to integrate local needs into the final design.

c) Value Engineering (VE)

USACE, St. Paul District conducted a value engineering study, which provided an objective look at the planning effort for the levee in an attempt to find additional cost-saving measures. The St. Paul District provided several recommendations that were incorporated into the design that helped to reduce project costs and environmental impacts. Following is a summary of these recommendations:

- Raise Saylor Road to eliminate a closure.
- Use a trapezoidal inspection trench with a two-foot bottom width, rather than an eight-foot bottom width, and reuse any suitable material from the trench.
- Use a slurry trench cut-off rather than a seepage berm at Riverview Park, which would significantly reduce the levee footprints (See Figure 8 and Figure 9)
- Replace riprap with articulated concrete mats.
- Use geotextile under the riprap.
- Dispose of unsuitable levee material on the outboard portion of the levee.

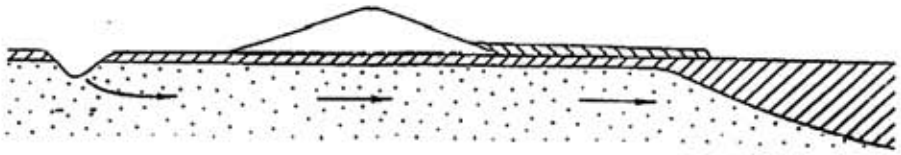

Figure 8: Seepage Berm

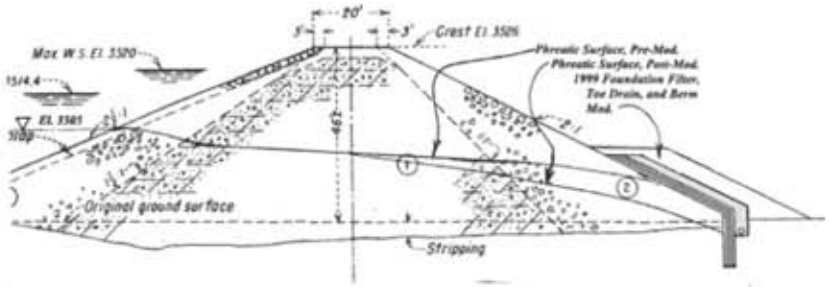

Figure 9: Cut-off Trench

d) Economic Analysis

Specifically, designs and associated costs were prepared for levee plans at a range of levee heights. Levee heights were selected based on elevations that were approximately three feet higher than the following flood profiles:

100-year (1.0 percent) exceedance frequency;

250-year (0.4 percent) exceedance frequency; and

500-year (0.2 percent) exceedance frequency

The net benefits associated with each of these plans were compared to define the optimized design elevation. These evaluations determined that the 500-year level of flood protection was feasible, had the highest net benefits of the plans evaluated, and the optimization curve had not yet turned downward. At that point, an evaluation of possible plans that would provide a higher level of protection were evaluated and coordinated with the City. An evaluation of probable costs to increase the level of protection greater than the 500-year level showed that the cost of a larger project would increase substantially because the environmental and real estate costs were prohibitive for higher alternatives. Therefore, the study team determined that it would be unlikely that the incremental costs of such a plan would be offset by the associated residual benefits. In addition, it was found that from the local perspective, construction of a larger project would result in substantial adverse social impacts. Discussions with the City of Des Moines (Sponsor) regarding the possibility of implementing a higher level-of-protection revealed that there was no support for such a plan because taking additional structures and increasing local construction and

operations costs are not politically or socially acceptable. The details of the initial evaluations and findings of the plan with the highest Net Annual Benefits are summarized in Table 13. Since the costs and benefits of at least one plan providing greater flood damage reduction (i.e. a larger plan) than the recommended plan is not presented, the report would not adequately demonstrate that the recommended plan is the NED Plan. Therefore, in accordance with paragraph 4-3b(2)(a) of ER 1105-2-100, the recommended plan should not be labeled as the NED Plan and should be labeled and presented as the Locally Preferred Plan.

Table 13: Birdland Park Alignment 2 Cost and Benefits (May 2004 price level)

Birdland Park	Top of Levee	Project Cost Estimate	Total First Costs	Annualized Annual First Costs	Annual O & M Costs	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits	Residual Annual Flood Damages
Alignment 2										
100 year	803.3	3,618,000	3,961,000	238,000	14,000	252,000	255,000	1.01	3,000	181,000
250 year	806.3	4,048,000	4,421,000	266,000	14,000	279,000	312,000	1.12	32,000	130,000
500 year	809.5	4,984,000	5,421,000	326,000	14,000	340,000	437,000	1.29	97,000	11,000
Recreation Trail		242,000	257,000	15,000	1,000	16,000	116,000	7.1	100,000	N/A

5-5/8% Discount Rate, 50-Year Evaluation Period

The recreational component of the project is also required to have a B/C ratio greater than 1. In Table 13, the cost estimates were calculated along with net annual benefits. The recreational features have a B/C ratio of 7.1, and therefore are included with the project.

4.E.7. Final Plan (Birdland Park)

The recommended and locally preferred plan is Alignment 2 at the 500-year level, including the recreational features. This plan would have a significant beneficial effect upon the local economy by allowing for future growth and improved public safety via improved flood protection. The plan also would improve recreational opportunities. The total fully-funded cost of the recommended multipurpose project is shown in Table 13. The combined flood damage reduction and recreation B/C ratio is 1.6. The City would serve as the Sponsor (the Sponsor) for the project.

The recommended plan for Reach 1 does not cause any increase in the 100-year regulatory flood profiles or increase ponding elevations for interior flooding. The existing levee defines the left floodway conveyance boundary for the Des Moines River and the interior drainage ponding characteristics. Reconstruction of the levee to a higher elevation would have minimal impacts on conveyance or storage of floodwaters for floods exceeding the 100-year flood. In addition, any increase in flood profiles that may occur would have negligible impact on properties not protected by the levee. USACE owns or has flood easements over most of the Des Moines River immediate floodplain upstream of 6th Avenue to facilitate high flows from Saylorville Reservoir. These lands are managed for floodplain, recreational and wildlife habitat uses, and is not available for future development. Because potential induced flood damages are negligible, mitigation measures are not necessary.

4.E.8. Plan Components Including Mitigation (Birdland Park)

The Birdland Park levee is approximately 7,700 feet in length. The crown width and levee height varies. The proposed levee would have a minimum crown width of 10 feet. A 15-foot crown width is required in places where a 10-foot recreation trail with adequate shoulders is constructed. Where the trail leaves the levee top construction of a 12-foot crown width would be maintained. A 12-foot wide top allows easier maintenance, inspection, and operation. The proposed side slopes are 3 feet horizontal to 1 foot vertical except along the river where riprap is proposed or where space limitations require a slightly steeper slope.

The proposed alignment follows the existing alignment until the levee reaches the upper end of the system near Riverview Park. At Riverview Park, the proposed alignment crosses the island creating a natural area to the west of the levee. A new gatewell and 42 inch RCP pipe would be constructed between the river and the lagoon to allow storm water to drain out of the lagoon. It would be closed during flooding. If necessary, the interior could be pumped out with a portable pump.

Existing stormwater pump stations are incorporated into the design. Gatewells and other crossing utilities are upgraded to meet Federal requirements. At the downstream end, a closure gate would be installed where Saylor Road crosses an opening in the levee. A retaining wall would prevent the levee from encroaching on the parking lot at the public park near Saylor Road. The existing Neal Smith multi-purpose recreation trail on the levee would be reconstructed as the levee is rebuilt. A new multi-purpose trail across the Riverview Park Island would connect McHenry Park with the existing Neal Smith Trail. The levee, which extends through Riverview Park, may contain landscaping and include an access trail over the levee.

The Chichaqua mitigation site would be excavated to an open water and wetland condition with bermed areas supporting upland trees and shrubs. Approximately 1.4 acres of upland forest, 0.2 acres of bottomland forest, 1.4 to 2.3 acres of emergent wetland, and 2.7 to 3.8 acres of open water would be impacted by the current alignment. The bottomland forest impacts include 0.6 acres of permanent filling through levee construction and 0.2 acres of permanent clearing of forested areas within 15 feet of the proposed levee alignment. These acreages would be finalized during plans and specifications. Approximately 6.4 acres of upland forest, 2.8 to 4.6 acres of emergent wetland, 1.2 acres of herbaceous upland buffer between the uplands and wetlands (this is an engineering feature that will reduce sedimentation runoff from the upland area into the wetland), and 2.7 to 3.8 acres of open water would be created at the Chichaqua mitigation site in the current plan. Approximately 0.4 acres of bottomland forest would be enhanced at the Central Place mitigation site for the Birdland bottomland forest impacts through planting of trees in an existing herbaceous wetland (see Figure W-1 in Volume 3). Complete details of the mitigation plan can be found in Appendix G, Section 1.

4.E.9. Design and Construction Considerations (Birdland Park)

Design and construction considerations vary for each levee system. See Appendix C, *Engineering Design* for a description of pertinent considerations.

An eight-foot wide inspection trench would insure unsuitable materials would be detected. Stanley consultants recommended rebuilding the riverside face of the levee. Materials stockpiled at the Harriet Street landfill appear to have suitable properties for rebuilding the core of the levee, however the Iowa State Land Recycling Program needs to determine the extent of remediation require before using this material. A major water line and power lines are located near the landside toe of the levee. A road closure would be designed to swing and lower into place. The design would eliminate the need for a brace. A seepage berm is sized so that enough landside load is establish for a minimum distance. A cutoff trench would sizably diminish the levee footprint. Please see section E *Design Considerations for Birdland Park* in Appendix C Volume 2.

4. F. REACH 2 - CENTRAL PLACE EVALUATION

The Central Place Business District is on the near north side of the City. This area was redeveloped as a commercial area in the 1970s and 1980s, and now is home to 109 commercial properties, 1 residential property, and 1 public property. The area is protected from flooding by a levee constructed by the City and is mapped in the National Flood Insurance Program as having 100-year flood protection. The levee was overtopped during the 1993 flood, causing extensive flood damages.

4.F.1. Existing Conditions (Central Place)

Based on the revised hydrologic and hydraulic modeling discussed in Volume 2 Appendix A, the 100-year flood profile of the Des Moines River at Central Place was determined to be essentially the same as the current flood insurance study (FIS) report.

Central Place is protected by a levee built by the City in 1950 that has been periodically upgraded. The levee generally consists of earth embankment except for 222 feet of concrete floodwall underneath University Avenue Bridge. The levee begins just north of 2nd Avenue, tying into high ground along the riverbank. It extends over a mile and a half along the river down to I-235. The levee upstream of University Avenue is 12 feet high, protecting approximately 200 acres of high value commercial property. From University Avenue to Interstate 235 (approximately 0.4 miles), the levee is integrated with the existing riverbank and protects West River Drive and a small park. The levee in this last portion of the reach is only a few feet high. The southern end blends into higher ground close to the Interstate.

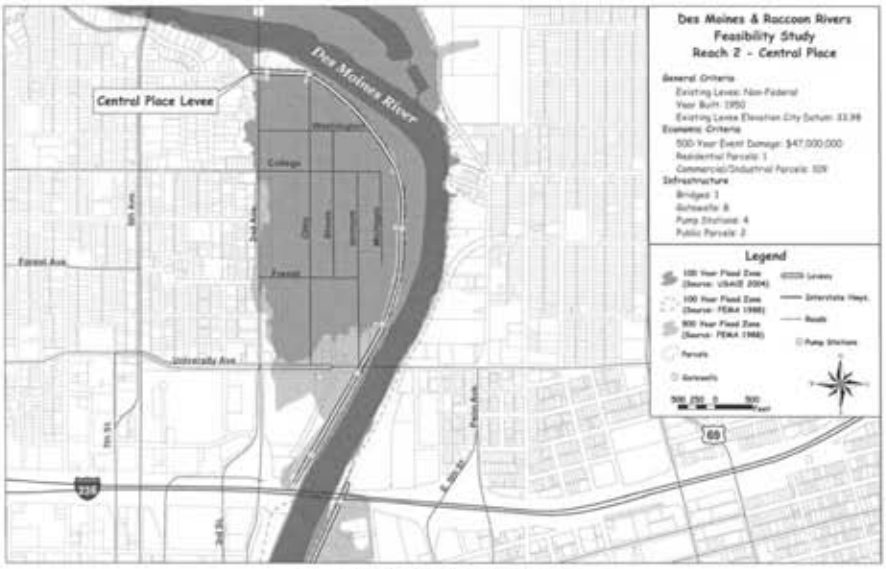

Figure 10: Central Place Project Area

The Central Place area is unique since it is lower than the normal river levels and, therefore, all runoff from the area must be pumped over the levee and into the river. All pump stations are in good shape, with new pumps and new pipe lining. All meet federal standards. The Central Place Business District is on the near north side of the City's central business district (Figure 10).

The levee is overgrown with trees on both slopes, extending from the crown beyond the toe on both sides (Figure 11). Animal holes and other debris in the levee have contributed to the following estimated probabilities of failure:

796.8 feet NGVD (Below the 50-year flood event) - 95% probability of failure

792.7 feet NGVD (Below the 5 to 10-year flood event) - 10% probability of failure

777.0 feet NGVD (Stream Bottom) - 0% probability of failure

The levee is currently used as an informal walking path and green space. The City has no plans to develop recreation features in the study area.

Hazardous, toxic, or radioactive waste (HTRW) soil testing confirmed the presence of arsenic, beryllium, and benzo(a)pyrene in excess of the Iowa Land Recycling Program statewide standards within the levee alignment and associated with the mitigation site at Central Place, however due to the very low concentrations the Iowa DNR has cleared the levee area and no remediation is required.

Figure 11: Central Place Levee, Showing Woody Vegetation

4.F.2. Future without Project Conditions (Central Place)

As with Birdland Park, it is highly unlikely that large a flood similar to the 1993 flood would be successfully fought and that resultant flood damage to the existing structures could exceed 50 percent of their value. Restrictions on the development of structures located in the floodplain would be required, consistent with the National Flood Insurance Program. The ongoing cost of flood insurance and the spiral of negative impacts associated with the community located within the regulatory floodplain remaining susceptible to flooding are unacceptable to City officials.

4.F.3. Problems and Opportunities (Central Place)

Problem: The existing levee has a high probability of failure due to instability of the levee embankment, putting at risk 111 primarily commercial properties.

Opportunities: Presently there are no recreational opportunities. The Central Place Levee system is currently not included in the City's long-range recreation development plans for future use of riverfront areas, which was initially thought during preliminary engineering design.

4.F.4. Measures Eliminated From Further Analysis (Central Place)

The following measures were eliminated form consideration:

- Pump station retention ponds were initially considered to increase storm water pumping efficiencies. The lack of available real estate, potential for hazardous contamination, and subsurface soil conditions caused this measure to be eliminated from further evaluation.
- Two lower levee heights (25-year and 50-year heights), were considered and eliminated, as the existing levee has enough material for a 250-year height and the cost to remove the excess material exceeded the economic benefits.

- As the downstream tie-off to high ground becomes very expensive and problematic for levees greater than 500-year elevations, higher levee elevations were also eliminated from further evaluation.

4.F.5. Selecting and Combining Measures into Alternatives (Central Place)

The study team developed conceptual plans for providing increased flood protection for the affected area, which, as in Birdland Park, was to reconstruct the existing levee at Central Place. The same levee alignment would be used, which is approximately 6,000 feet in length, and would have side slopes measuring between 3' to 4' horizontal to 1' vertical. A one-foot superiority elevation would be added upstream and existing pump stations utility crossings would be incorporated into the new design. The levee height would be optimized through incremental cost analysis. The same stockpile of material proposed for use in the Birdland Park levee plan would be utilized for Central Place levee construction.

4.F.6. Screening of Alternative Plans (Central Place)

Environmental Impacts: The same inter-agency team that evaluated the impacts of the Birdland levee also evaluated the environmental impacts of the Central Place levee using EXHEP. Approximately 1.2 acres of wetland bottomland forest and 3.2 acres of upland forest are impacted with the current levee alignment, a total of 4.4 acres The same 4.4 acres would be impacted at all levee heights considered. During final design all due consideration should be made to reduce the impact to the 1.2 acres of wetland bottomland forest by shifting the levee landward by up to 15 feet. The current levee design calls for a 15 ft top width to accommodate a recreational trail. Since it has been determined that there is not a need or desire by the City for a trail a 10 ft levee top width would be considered to lessen the impact to wetlands or create additional wetland which could mitigate for other project impacts. Again, informal consultation between the USFWS and the District determined that a biological assessment would not be required for the proposed project.

The same mitigation site proposed for the Birdland Park levee was selected for mitigating some of the impacts to the upland forest habitat (see Figure 12). The remaining upland forest mitigation would be located in an existing mowed upland area riverside of the northern portion of the Central Place levee. The bottomland forest mitigation would occur within the non-forested portion of the wetland located on the riverside of the levee. The only environmental and social impact involves the removal of trees and shrubs, which would decrease the aesthetic value of the view-shed.

Value Engineering: The VE study performed for the Birdland Park levee by the St. Paul District was incorporated into the analysis used for Central Place because of the similarities in design, construction, and conditions. Articulated concrete mat rather than stone protection along the Des Moines River would be considered. The St. Paul District also recommended that unsuitable material found in the levee and inspection trench areas be disposed of on-site rather than hauled off site. Organic material and trash would still be required to be hauled off-site; however, broken concrete and large rocks that cannot be used in the levee embankment could be placed outside of the levee template and covered so that is not unsightly. A 2-foot inspection trench would replace the current 8-foot inspection trench.

Economic Analysis: Following USACE regulations to account for the risk and uncertainty in a design, a detailed process was undertaken to determine the top of levee elevation relative to the design of water surface elevation. A confidence interval was established around the various design parameters, and a quantitative analysis was performed to assure that the top-of-levee has a high probability of containing the design flood event. In addition, upstream superiority elevation would be added to assure that any overtopping event occurs first at the downstream end of the project. With a B/C ratio of 3.34, as shown in Table 14, the recommended plan for Reach 2 is to reconstruct the levee to protect against a 500-year flood. Since the costs and benefits of at least one plan providing greater flood damage reduction (i.e. a

larger plan) than the recommended plan is not presented, the report does not adequately demonstrate that the recommended plan is the NED Plan.

Figure 12: Central Place Mitigation Site for Upland and Bottomland Forest

Table 14: Central Place Cost Benefit Evaluation (May 2004 price level)

Central Place	Top of Levee	Project Cost Estimate	Total First Costs	Annualized First Costs	Annual O & M Costs	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits	Residual Annual Flood Damages
100 year	802.3	3,156,000	3,396,000	204,000	15,000	219,000	667,000	3.05	448,000	235,000
250 year	805.3	3,420,000	3,678,000	221,000	15,000	236,000	764,000	3.24	528,000	139,000
500 year	808.7	3,839,000	4,126,000	248,000	15,000	263,000	895,000	3.4	632,000	8,000

5-5/8% Discount Rate, 50-Year Evaluation Period

4.F.7. Final Plan (Central Place)

The recommended and locally preferred plan is to construct a levee to the 500-year protection level. This plan would have a significant beneficial effect upon the local economy by allowing for future growth and improved public safety with improved flood protection. The fully funded cost of the recommended plan is shown in Table 24. The B/C ratio is 3.4.

The recommended plan for Reach 2 does not cause any increase in the 100-year regulatory flood profiles or increase ponding elevations for interior flooding. The existing levee defines the right floodway boundary for the Des Moines River and the interior drainage ponding characteristics. Reconstruction of the levee to a higher elevation would have minimal impacts on conveyance or storage of flood waters for floods exceeding the 100-year flood. In addition, any increase in flood profiles would have negligible impact on properties not protected by the levee. The floodplain lands across the river and upstream of the Central Place levee are managed for floodplain, public recreational and wildlife habitat uses, and is not available for future development. Because potential induced flood damages are negligible, mitigation measures are not necessary.

4.F.8. Plan Components Including Mitigation (Central Place)

The proposed upgraded levee is approximately 5,900 feet in length. The proposed crown width is 12 feet. The alignment would follow the existing alignment and tie to the north side of the University Avenue Bridge embankment. Side slopes would be constructed with slopes equal to 3' horizontal and 1' vertical. Sufficient material exists on site to construct the proposed levee. Two new gatewells would be constructed, and three older pump stations would be upgraded to include new discharge pipes constructed over the levee. Trees and shrubs would be removed from the levee and 15 feet out from the levee toe. Mitigation for loss of habitat would be accomplished on site and at the Chichaqua site. Approximately 3.2 acres of upland forest would be impacted and 1.2 acres of bottomland forest would be impacted. Approximately 2.2 acres of upland forest would be created on-site and 3.8 acres of upland forest would be created at the Chichaqua site. Approximately 2.2 acres of bottomland forest would be enhanced on-site through planting of trees in an existing herbaceous wetland.

4.F.9. Design and Construction Considerations (Central Place)

Design and construction considerations vary for each levee system. See Appendix C, *Engineering Design* for a description of pertinent considerations.

Minimize impacts to wetland bottomland forest (all resources outward from the levee toe) by moving the levee landward so the needed 15 foot clear zone (free of trees and shrubs) is within the current levee footprint. The reduction of the levee top width should also be evaluated to determine the feasibility of reducing wetland impacts or creating additional wetland habitat. The embankment should not include abandoned utilities, debris, tree growth, animal burrows, or other items or deficiencies that could lead to failure of the embankment. An alternative to minimize costs is to remove and replace the riverside

portion of the levee. The horizontal thickness of the compacted layer is about 15 feet. This would provide sufficient room for compaction equipment and replace enough levee embankments to provide levee stability. The standard USACE inspection trench for this size levee is 6 feet deep and 8 to 10 feet wide.

4. G. REACH 3 - DOWNTOWN EAST EVALUATION

Reach 3 is the easterly levee bank of the Des Moines River from University Avenue downstream to the Sewage Treatment Plant and the beginning of the Red Rock Remedial Works levee (Figure 13). The levee has numerous roads, railroad closures, utility crossings, and storm water outfalls. The downtown portion is part of riverfront development program called Des Moines Recreational River and Greenbelt (Greenbelt).

4.G.1. Existing Conditions (Downtown East)

The protected area contains the central business core of the City with over 1,800 acres of highly urbanized commercial, retail, industrial, residential, and public facilities as shown in Volume 3, Figure 5. The Downtown East area is a fully-developed urban area containing 227 residential properties, 272 commercial or industrial properties, and 9 public properties.

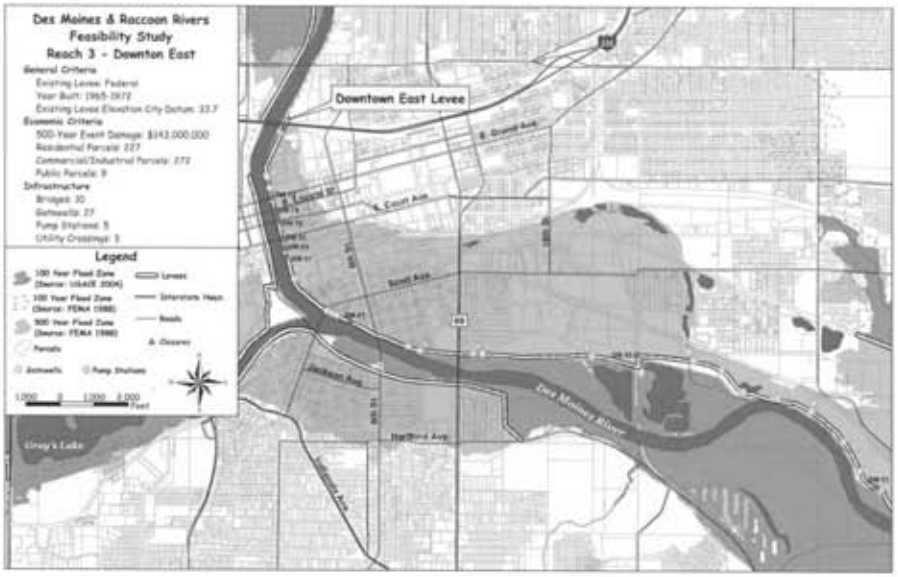

Figure 13: Reach 3 Downtown East Study Area

The existing levee system was designed to provide slightly more than 100-year flood protection. This system, designed in the 1960s, has numerous street and sewer closures that penetrate the line-of-protection at the design flood level. This situation causes the City to take multiple operational actions

during a flood event, including sandbagging, installing earthen closures, and placing and operating portable pumps. However, as demonstrated during the 1993 flood, floodwaters on both the Des Moines and Raccoon Rivers can rise rapidly, making the successful execution of these operations difficult.

A multi-use trail, the John Pat Dorrian Trail, is a segment of the longer Saylorville Trail. The John Pat Dorrian Trail runs from Hawthorne Park north to University Avenue along the Des Moines River for approximately 2.2 miles. Trailheads are located at Hawthorne Park, Botanical Center riverfront parking lot under the University Bridge, and several other points along the trail, including the Armory parking lot and City Hall.

Hazardous, toxic, or radioactive waste (HTRW) soil testing confirmed the presence of arsenic, beryllium, and benzo(a)pyrene. Groundwater testing indicated the presence of arsenic, beryllium, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene in excess of the Iowa Land Recycling Program statewide standards. HTRW clearance has been obtained from the State of Iowa in a letter dated 7 February 2005 and is located in Appendix H.

The Downtown East area is fully urbanized dominated by buildings, pavement, mowed grass, and scattered ornamental trees. The levee in this area is well maintained and regularly mowed. This reach is located within the Civic Center Historic District, which is a National Register of Historic Places multiple-property listing based on thematic areas of significance including architecture, community planning and development, and landscape architecture dating from 1892 to 1938. The historic places nomination includes seven contributing structures, six contributing buildings, and five noncontributing structures. Seven closure structures proposed for Reach 3 are located within the Civic Center Historic District including one adjacent to the Court Avenue Bridge, a contributing resource to the NRHP Civic Center Historic District nomination, and one adjacent to the Des Moines Union Railway Bridge, a noncontributing structure that has been determined individually eligible for inclusion on the NRHP.

4.G.2. Future without Project Conditions (Downtown East)

The Downtown East road and railroad closures would continue to be at risk during flood events. Demands for recreational facilities in the City have and would continue to increase. No substantial changes in environmental or cultural conditions should occur.

4.G.3. Problems and Opportunities (Downtown East)

Problems: The existing levee was over topped during the 1993 flood.

Problems: Flood fighting along Reach 3 requires construction of temporary closures during major flood events, including staging and installing clay embankment plugs or plastic sheeting and sand bag structures to repel the floodwaters. Nevertheless, as was the case in the 1993 flood, floodwaters rose rapidly, jeopardizing successful placement of these closures.

Opportunities: There are opportunities for recreational features as part of the City's Riverfront development; however, because of a special Greenbelt authorization for the City, recreational opportunities would be coordinated through that program. Flood damage reduction structures would be designed in cooperation with the Greenbelt projects.

4.G.4. Selecting and Combining Measures into Alternatives (Downtown East)

Two measures were considered to reduce flood damages, raising the existing levee and floodwalls from slightly over 100-year level to the 500-year level of protection, which is an estimated raise of 3 feet and redesigning existing closure structures to increase their constructability and reliability during flood fighting. Three alternative approaches were evaluated for redesigning the existing closures that are part of the levee system:

- One, permanently close existing openings that are no longer needed
- Two install gate structures to ensure quick and reliable closure
- Three, reduce the size of the opening and change the alignment to lower the height of the temporary closure and improve stability/reliability. (The change in alignment would also enable the streets to remain open longer during flood events)

Eleven closures were identified for modification or elimination and a simple risk-based analysis was performed. See Appendix C, Section 4e1 for details. Four of the closures were identified as being no longer needed and could be permanently closed. The existing closures at Simon Estes Amphitheater could be gated or stop logs used, and six other closures on different roads would benefit from having the opening width of each closure reduced. See Table 16 for closure description and proposed design. All alternative closure alternatives were coordinated with the riverfront redesign and reconstruction Greenbelt project authority and the City.

- Permanent Closure, DM 41 – R.R. Bridge
- Reduce Closure, DM 45-R.R. Bridge
- Permanent Closure, DM 51-Build-up, Gravel Rd. at downstream end of Des Moines wastewater treatment plant
- Reduce Closure, DM 73-Grand Ave
- Reduce Closure, DM 75-Locust St.
- Install gates at existing pedestrian walkway closures at Simon Estes Amphitheater feature
- Reduce Closure, DM 79-Walnut St.
- Reduce Closure, DM 81-Court Ave.
- Permanent Closure, DM 85-R.R. Bridge South of Court St.
- Reduce Closure, DM 87-R.R Bridge at Vine St
- Permanent Closure-Tie upper end of Levee into I-235 embankment

4.G.5. Screening of Alternatives (Downtown East)

A preliminary cost estimate for a levee raise to 500-year level was determined to have a low B/C ratio—less than 0.17—eliminating this measure from further analysis.

The study team had developed overall flood-fighting "reliability and risk" base matrix, analyzing the likelihood for closure failure, assuming all the closures in the city would need to be closed. These risk and uncertainty values were input into the FDA model, which computed the economic benefits. The only two effective alternatives (Table 15) are the "No Action" alternative or to construct closure modifications. With a B/C ratio of 3.8, the recommended plan is to construct15 closure modifications.

An analysis of temporary structures was also made, results of which are in Appendix C, *Engineering Evaluation*. An environmental survey was conducted, which indicated that there would be no significant impacts. A cultural survey and coordination with the State Historical Society of Iowa were also conducted. No known historic sites exist in this study area (see Environmental and Cultural Inventories starting on 73).

Table 15: Downtown East Closures and Levee Raise Cost Benefit Analysis (May 2004 price level)

Downtown East Leve	Project Cost Estimate	Total First Costs	Annualized First Costs	Annual O & M Costs	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits	Residual Annual Flood Damages
Closure Improvements	642,000	679,000	41,000	0	41,000	156,000	3.8	115,000	252,000
500 year levee	11,440,000	12,510,000	7,520,000	10,000	762,000	113,000	0.15	-649,000	

4.G.6. Final Plan (Downtown East)

A major desire of the project partner, the City, was to maximize flood damage reduction at a reasonable cost. After review of the Feasibility Report, modification of 11 closures, which significantly reduces flood damage, is both the recommended and locally preferred plan. Four closures would be permanently closed. The Simon Estes Amphitheater closure would have gate structures installed, and six other road closures would have their opening widths reduced. A detailed description of these closures can be found in Appendix C, *Engineering Evaluation*.

Since the costs and benefits of at least one plan providing greater flood damage reduction (i.e. a larger plan) than the recommended plan is not presented, the report does not adequately demonstrate that the recommended plan is the NED Plan.

The recommended plan for Reach 3 does not cause an increase in flood profiles or increase ponding elevations for interior flooding. (Because there are no induced flood damages, mitigation measures are not necessary.)

4.G.7. Plan Components Including Mitigation (Downtown East)

The downtown levees and floodwalls are currently designed to protect for slightly over a 100-year flood event. Four closures would be made permanent and closures at several locations would be modified to reduce the opening size and increase system reliability as described below and shown on Plates D3-D12 in Volume 3:

Table 16: Existing Closure Conditions and Proposed Correction, Downtown East

Closure Title Total of 11 Closures	Existing Open Width	Future Opening Width	Proposed Closure Design	Length Closure Material	Height Closure Material	Buried / Depth
DM 41 - R.R. Bridge Permanent Closure	50 ft	0 ft	12 ft' crown & 30 ft base levee	70 ft	3 ft	n/a
DM 45 - R.R. Bridge – Reduce Closure	45 ft	20 ft	12" concrete walls on either side of tracks	25 ft	3 ft	5 ft
DM 51 - Build-up Vandalia, Gravel Rd - Permanent Closure	100 ft	0 ft	28 ft crown & 300 ft base levee	120 ft	8 ft	6 ft
DM 73- Grand Ave. – Reduce Closure	137 ft	85 ft	12" concrete walls on either side of road	32 & 34 ft	3 ft	5 ft
DM 75 - Locust St. – Reduce Closure,	85 ft	70 ft	12" concrete walls on either side of road	45 ft	3 ft	5 ft
Simon Estes Amphitheater – Gates at existing pedestrian Closure	7 ft	7 ft	Variety of gate or stop log closures	7 ft	4 ft	n/a
DM 79 - Walnut St. – Reduce Closure	150 ft	85 ft	12" concrete walls on either side of road	100 ft	3 ft	5 ft

Closure Title Total of 11 Closures	Existing Open Width	Future Opening Width	Proposed Closure Design	Length Closure Material	Height Closure Material	Buried / Depth
DM 81 – Court Ave. Reduce Closure	165 ft	100 ft	12" concrete walls on either side of road	35 & 25 ft	3 ft	5 ft
DM 85 - R.R. Bridge South of Court St. - Permanent Closure,	40 ft	0 ft	12 ft crown & 36 ft Base levee	60 ft	4 ft	n/a
DM 87 – R.R. Bridge – Reduce Closure	45 ft	20 ft	12" concrete walls on either side of tracks	25 ft	3 ft	5 ft
I-235 Embankment, Tie upper end of Levee - Permanent Closure	60 ft	0 ft	12 ft crown & 48 ft Base Levee	80 ft	6 ft	6 ft

Note: Because of the concurrent riverfront redesign and reconstruction Greenbelt project, detailed designs for closures would be performed in final design in conjunction with Greenbelt River front development design. No environmental mitigation is necessary.

4.G.8. Design and Construction Considerations (Downtown East)

Detail design for each of the closures would be completed during final design. Many of the closures must conform to new architectural concepts and designs for the Greenbelt River Front project, much of which has not been completed. Bridge tie-ins and location of flood wall extensions would be developed in conjunction with Greenbelt projects. See Volume 3, *Figures, Exhibits, and Plates*.

4. H. REACH 4 - DOWNTOWN WEST EVALUATION

This levee follows the westerly bank of the Des Moines River 1,000 feet downstream of I-235 to the confluence of the Raccoon River then along the northern bank of the Raccoon River past Fleur Drive, see Figure 14.

4.H.1. Existing Conditions (Downtown West)

The existing federal levee and floodwalls, constructed in the 1960s through the1970s, currently offers protection for slightly over a 100-year flood event. Three pump stations remove stormwater from behind the levee during flooding. Ten closures need to be closed during flooding. The levee is currently used as an informal walking path and green space. Hazardous, toxic, or radioactive waste (HTRW) soil testing confirmed the presence of arsenic, beryllium, and benzo(a)pyrene in excess of the Iowa Statewide Standard throughout the levee alignment. Groundwater analysis confirmed the presence of arsenic, cadmium, barium, thallium, beryllium, chromium, lead, manganese, molybdenum, nickel, selenium, vanadium, and zinc. Contaminant concentrations were in excess of the Iowa Land Recycling Program statewide standards. While Phase IIA assessments were conducted for much of this project area, the assessments did not include the west side of the Des Moines River between Center Street and Riverview Park, even though the Phase I ESA indicated environmental concerns. At the time the Phase IIA ESA was awarded (December 2003), the City of Des Moines was performing significant construction activities in this area that might have removed existing material to a depth of 20 feet.

HTRW clearance has been obtained from the State of Iowa in a letter dated 7 February 2005 and is located in Appendix H.

The Downtown West area is a fully urbanized area, which includes 182 commercial or industrial properties and 3 public properties. It is dominated by buildings, pavement, and mowed grass, with scattered ornamental trees. The levee in this area is well maintained and regularly mowed.

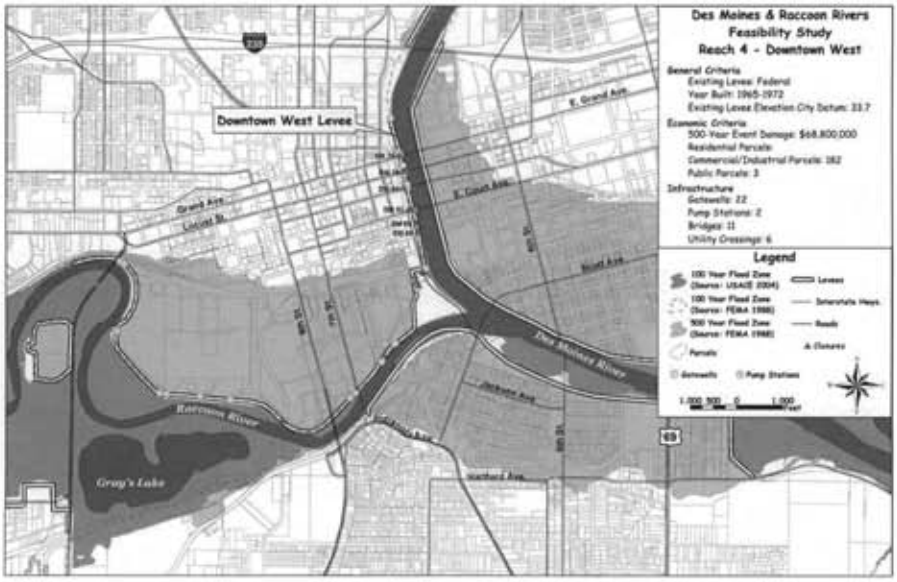

Figure 14: Reach 4 Downtown West Study Area

A portion of Reach 4 is located within the Civic Center Historic District and within the boundaries of National Register for Historic Properties (NRHP) eligible archeological site 13PK61, sees Environmental and Cultural Inventories starting on page 72. Four closure structures are proposed within the site boundaries of archeological site 13PK61. Site 13PK61, Fort Des Moines No. 2, is a multi-component prehistoric and historic archeological site. Numerous investigations have evaluated portions of the site and it was formally included in the NRHP in 2000.

4.H.2. Future without Project Conditions (Downtown West)

The Downtown West road and railroad closures would continue to be at risk during flood events. Demands for recreational facilities in the City have and would continue to increase. No substantial changes in environmental or cultural conditions would occur.

4.H.3. Problems and Opportunities (Downtown West)

Problems: Flood fighting along Reach 4 requires construction of temporary closures during major flood events. These structures have failed in the past causing serous flood damages.

Opportunities: As in Reach 3 the Greenbelt, riverfront development would implement any recreational opportunities.

4.H.4. Selecting and Combining Measures into Alternatives (Downtown West)

Two measures were considered to reduce flood damages, raising the existing levee and floodwalls from slightly over 100 year level to the 500-year level of protection, which is an estimated raise of 3 feet. In addition, existing closures were redesigned to increase their constructability and reliability. Three

alternative approaches were evaluated for redesigning the existing closures that are part of the levee system:

- Permanently close existing openings that are no longer needed
- Install gate structures to ensure quick and reliable closure
- Reduce the size of the opening and change the alignment to lower the height of the temporary closure and improve stability/reliability. (The change in alignment would also enable the streets to remain open longer during flood events)

Six closures were identified for modification and a simple risk based analysis was performed, see Appendix C, Section 4e1 for details. One closure was no longer needed and could be permanently closed. Five more would benefit from having the width of temporary closures reduced, see Table 18 for closure description and proposed design. All alternative closure alternatives were coordinated with the riverfront redesign and reconstruction Greenbelt project authority and the City.

- Reduce Closure, DM 76-Grand Ave.
- Reduce Closure, DM 78-Locust St.
- Reduce Closure, DM 80-Walnut St.
- Reduce Closure, DM 82-Court Ave.
- Permanent Closure, DM 86-R.R
- Reduce Closure, DM 88-R.R.

4.II.5. Screening of Alternatives (Downtown West)

A preliminary cost estimate for a levee raise to 500-year level was determined to have a low B/C ratio less than 0.29 eliminating this measure from further analysis.

As in Reach 3 the study team applied the same flood-fighting reliability and risk base matrix, and input these into the FDA model, which computed the economic benefits. If the closures received the recommended modifications, the time to make closures would decrease, for detailed analysis. See Engineering Appendix C Volume II.

An environmental survey was conducted, which indicated that there would be no significant impacts. Consultation with the State Historical Society of Iowa concluded that the actions described in the final plan would have "no adverse effects" on the archeological site 13PK61, the Civic Center Historic District, or on the Des Moines Union Railway Bridge (see Environmental and Cultural Inventories starting on page 72).

The only two effective alternatives (see Table 17) are the No Action and to construct closures modifications. A detailed incremental cost analysis was not performed due to the small project cost. With a B/C ratio of 4.5, the recommended plan is to construct 6 closure modifications.

Table 17: Downtown West Closures and Levee Raise Cost Benefit Analysis (May 2004 price level)

Downtown West Levee	Project Cost Estimate	Total First Costs	Annualized First Costs	Annual O & M Costs	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits	Residual Annual Flood Damages
Closure Improvements	260,000	275,000	17,000	0	17,000	74,000	4.5	57,000	252,000
500 year levee	4,943,000	5,472,000	329,000	10,000	339,000	97,000	0.29	-241,000	

5-5/8% Discount Rate, 50-Year Evaluation Period

4.H.6. Final Plan (Downtown West)

A major desire of the project partner, the City, was to maximize flood damage reduction at a reasonable cost. After review of the Feasibility Report, the recommended and locally preferred plan is to modify six closures, to reduce flood damages. One closure would be made permanent, while five other closures would be reduced in opening width. A detailed description of these closures can be found the Engineering Appendix C Volume II.

Since the costs and benefits of at least one plan providing greater flood damage reduction (i.e. a larger plan) than the recommended plan is not presented, the report does not adequately demonstrate that the recommended plan is the NED Plan.

The recommended plan for Reach 4 does not cause an increase in flood profiles or increase ponding elevations for interior flooding. Because there are no induced flood damages, mitigation measures are not necessary

4.H.7. Plan Components Including Mitigation (Downtown West)

One closure would be made permanent; and five closures would be improved to reduce the opening size and increased system reliability as described below and shown on Plates D15-D22 in Volume 3:

4.H.8. Design and Construction Considerations (Downtown West)

Design and construction considerations vary for each levee system. See Appendix C, Engineering Design for a description of pertinent considerations, see Table 18.

Table 18: Existing Closure Conditions and Proposed Correction, Downtown West

Closure Title Total of 6 Closures	Existing Open Width	Future Open Width	Proposed Closure Design	Length Closure Materials	Height Closure Materials	Buried/Depth
DM 76- Grand Ave Reduce Closure	120 ft	80 ft	12 in Concrete	100 ft	3 ft	5 ft
DM 78- Locust St. Reduce Closure	100 ft	70 ft	12 in Concrete	100 ft	3 ft	5 ft
DM 80- Walnut St. Reduce Closure	135 ft	0	12 in Concrete	80 ft	4 ft	n/a
DM 82- Court Ave. Reduce Closure	165 ft	100 ft	12 in Concrete	80 ft	3 ft	5 ft
DM 86-R.R Permanent Closure	140 ft	0	12 ft Crown & 36 ft Base	80 ft	4 ft	n/a
DM 88- R. R. Reduce Closure	80 ft	20 ft	12 ft Crown & 30 ft Base	30 ft	3 ft	n/a

No environmental mitigation is necessary.

4. I. REACH 5 – DOWNTOWN SOUTH EVALUATION

Downtown South Reach is on the southerly bank of the Raccoon River (see Figure 15: Reach 5 Downtown South Study Area). The levee starts downstream of SW 7th Street and continues along the Des Moines River to Hartford Avenue.

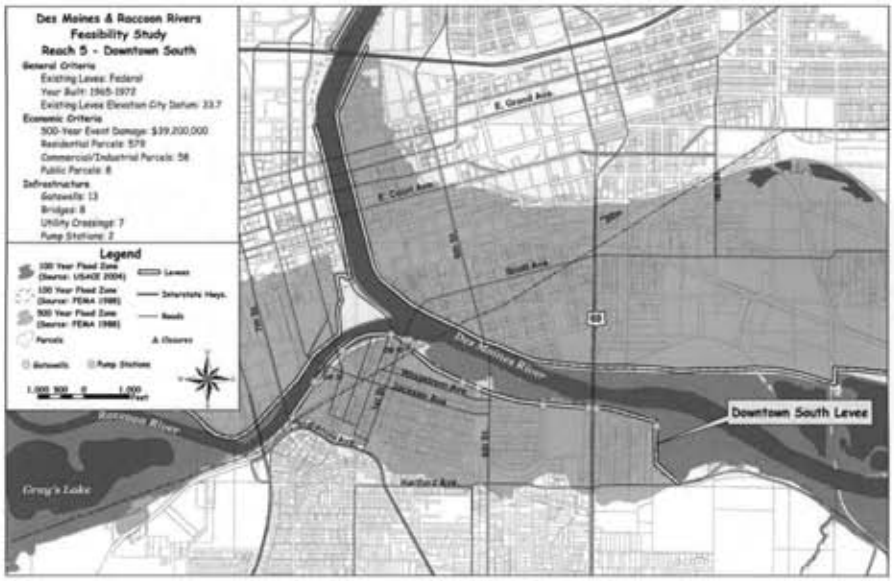

Figure 15: Reach 5 Downtown South Study Area

4.1.1. Existing Conditions (Downtown South)

Reach 5 is protected by a federal levee providing slightly over a 100-year flood protection. The levee consists of grass covered earthen embankments, floodwalls and closures at 1st Street, Scott Avenue, SE 6th Street, and SE 14th Street. Three pump stations remove storm water during flooding.

Kruidenier Trail is a multi-use recreational trail. The trail at Gray's Lake Park, 2100 Fleur Drive, is located within the park and is within 2,000 feet of the levee. It is known among the City's trails for the 1500-foot bridge that allows the trail to encircle the lake for approximately 2.0 miles. All parking lots located within the park provide beginning and ending points for this circular trail. This trail is 2,000 feet from the levee.

The HTRW Phase I Environmental Site Assessment found no recognized environmental conditions for this location. As a result, no further investigations were conducted.

The Downtown South area is a fully developed urban area, including 579 residential properties, 58 commercial or industrial properties, and 8 public properties. It is dominated by buildings, pavement and mowed grass, with scattered ornamental trees. The levee in this area is well maintained and regularly mowed. A portion of Reach 5 is located within the Civic Center Historic District along with one of the closures.

4.1.2. Future without Project Conditions (Downtown South)

The Downtown South road and railroad closures would continue to be at risk during flood events. Demands for recreational facilities in the City have and would continue to increase. No substantial changes in environmental or cultural conditions should occur.

4.I.3. Problems and Opportunities (Downtown South)

Problems: Flood fighting along Reach 5 requires construction of temporary closures during major flood events. These structures have failed in the past causing serous flood damage.

Opportunities: As in Reach 3 the "Greenbelt riverfront development would implement any recreational opportunities.

4.I.4. Selecting and Combining Measures into Alternatives (Downtown South)

Two measures were considered to reduce flood damages, raising the existing levee and floodwalls from slightly over 100 year level to the 500-year level of protection, which is an estimated raise of 3 feet. In addition, existing closures were redesigned to increase their constructability and reliability. Three alternative approaches were evaluated for redesigning the existing closures that are part of the levee system:

- Permanently close existing openings that are no longer needed
- Install gate structures to ensure quick and reliable closure
- Reduce the size of the opening and change the alignment to lower the height of the temporary closure and improve stability/reliability. (The change in alignment would also enable the streets to remain open longer during flood events)

Two closures were identified for modification and a simple risk based analysis was performed see (Appendix C, Section 4e1) for details. Both closure are no longer needed and could be permanently closed, see Table 20 for closure description and proposed design). All alternative closure alternatives were coordinated with the riverfront redesign and reconstruction Greenbelt project authority and the City.

- Permanent Closure, DM 36 R.R. W. 7th Street
- Permanent Closure, DM 42-S.E. 1st St. & Riverview Dr.

4.I.5. Screening of Alternatives (Downtown South)

A preliminary cost estimate for a levee raise to 500-year level was determined to have a low B/C ratio less than 0.07 eliminating this measure from further analysis.

As in Reach 3, the study team applied the same flood-fighting reliability and risk base matrix and input these into the FDA model, which computed the economic benefits. If the closures received the recommended modifications, the time to make closures would decrease (for detailed analysis see Engineering Appendix C Volume II).

An environmental survey was conducted, which indicated that there would be no significant impacts. A cultural survey was also conducted, which determined that there were no known cultural resources (see Environmental and Cultural Inventories starting on page 73).

The only two effective alternatives (see Table 19) are the No Action and to construct closures modifications. A detailed incremental cost analysis was not performed due to the small project cost. With a B/C ratio of 15.3, the recommended plan is to construct 2 closure modifications.

Table 19: Downtown South Closures and Levee Raise Cost Benefit Analysis (May 2004 price level)

Downtown South Levee	Project Cost Estimate	Total First Costs	Annualized First Costs	Annual O & M Costs	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits	Residual Annual Flood Damages
Closure Improvements	31,000	33,000	2,000	0	2,000	30,000	15.3	28,000	46,000
500 year levee	6,175,000	6,752,000	406,000	10,000	416,000	29,000	0.07	-388,000	

5-5/8% Discount Rate, 50-Year Evaluation Period

4.I.6. Final Plan (Downtown South)

A major desire of the project partner, the City, was to maximize flood damage reduction at a reasonable cost. After review of the Feasibility Report, both the recommended locally preferred plan is to modify two closures, both of which would be permanently closed. A detailed description of these closures can be found in Volume 2, Appendix C: *Engineering Design*.

Since the costs and benefits of at least one plan providing greater flood damage reduction (i.e. a larger plan) than the recommended plan is not presented, the report does not adequately demonstrate that the recommended plan is the NED Plan.

The recommended plan for Reach 5 does not cause an increase in flood profiles or increase ponding elevations for interior flooding. Because there are no induced flood damages, mitigation measures are not necessary.

4.I.7. Plan Components Including Mitigation (Downtown South)

Two closures would be made permanent at the following locations listed below and shown on Plates D24-D27 in Volume 3:

4.I.8. Design and Construction Considerations (Downtown South)

Design and construction considerations vary for each levee system. See Appendix C, *Engineering Design* for a description of pertinent considerations; also see a summary description of the closures in Table 20.

Table 20: Existing Closure Conditions and Proposed Correction, Downtown South

Closure Title Total of 2 Closures	Existing Open Width	Future Open Width	Proposed Closure Design	Length Closure Material	Height Closure Material	Buried / Depth
DM 36-R.R. S.W. 7th St. Permanent Closure	60	0	12' Crown & 42' Base	40 ft	6 ft	6 ft
DM 42 - S.E. 1st St. & Riverside Dr. Permanent Closure	70	0	12' Crown & 36' Base	45 ft	5 ft	6 ft

No environmental mitigation is necessary.

4. J. REACH 6 – RACCOON RIVER SECTION 205 LEVEE EVALUATION

This existing federal levee was built under the authority of Section 205 of the 1948 Flood Control Act. The levee was completed in 2000 and is located along the south bank of the Raccoon River from SW 30th Street downstream to the railroad closure west of Fleur Drive, approximately three miles upstream of the confluence with the Des Moines River (Figure 16). The Federal levee was constructed by reconstructing an existing non-federal levee.

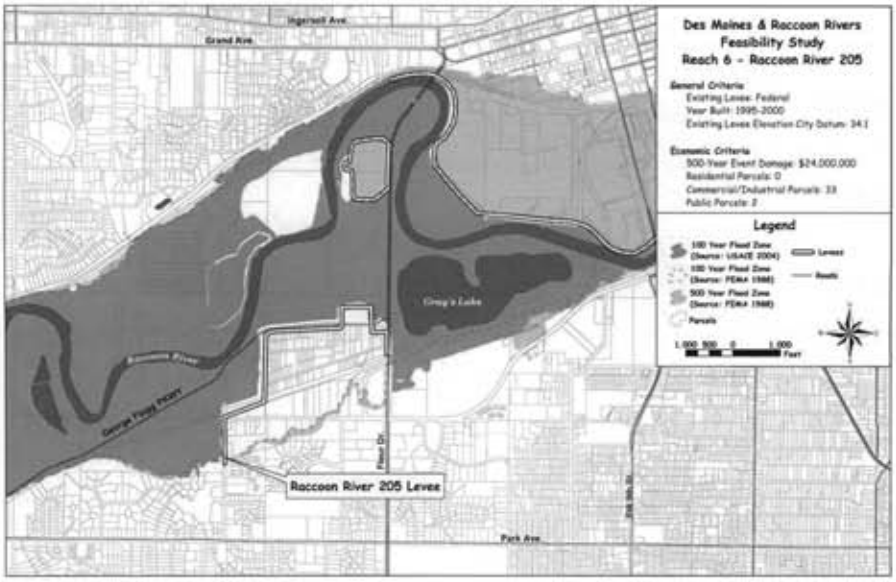

Figure 16: Reach 6 Raccoon River 205 Study Area

During the 1993 flood, the levee in this reach was overtopped and the area suffered extensive flood damages. The new federal levee was designed to provide a more than 100-year level of protection. As a result of the hydrologic and hydraulic analyses completed in Phase 1 of the study, it was determined that the estimated flood profiles have increased approximately one foot since the time the existing levee was designed. Despite this increase, the levee is in very good condition and is now estimated to provide slightly more than 100-year level of flood protection. The existing levee provides flood protection to 130 acres of moderately developed urban land. Behind the levee are 33 commercial and light industrial properties, a few older residential homes, and two public properties.

There are no recreation facilities on or adjacent to the levee and there appears to be little demand for such facilities. The City has developed an extensive trail system at Gray's Lake, just east of this area, which is used intensively, and plans are underway to connect the Gray's Lake facilities with the Riverwalk recreation facilities proposed for downtown Des Moines. The City has no plans to develop recreation features along or adjacent to the levee.

The Phase I Environmental Site Assessment found no recognized environmental conditions for this location. As a result, no further investigations were conducted.

There is little apparent growth in this area, and no demand for recreational facilities on the levee is anticipated. No substantial changes in environmental or cultural conditions are expected.

Non-structural measures were eliminated from consideration because structures in this reach are protected by the existing levee. It is not necessary or economically feasible to relocate, raise, or floodproof the structures.

Channel conveyance in the Raccoon River is severely limited by bridges and other structures in the floodplain, and modification of the channel to increase conveyance is not economically feasible. An

alternative to raise the height of the existing levee was conceptually developed but was determined to be not economically feasible. Based on this evaluation, there are no economically feasible flood damage reduction alternatives that can be applied to Reach 6, Raccoon River Section 205 Levee. The "No Action" alternative was selected for this reach.

4. K. REACH 7 – DES MOINES WATER WORKS LEVEE EVALUATION

The Des Moines Water Works (DMWW) is a publicly owned incorporated utility providing drinking water to more than 300,000 people in the Des Moines, Iowa, metropolitan area. The utility was established as a private company in 1871 and was purchased by the City in 1919. It is the largest water utility in Iowa, and is among the largest 100 utilities in the country. The main treatment plant is located in the Raccoon River floodplain along Fleur Drive (Figure 17).

The Des Moines Water Works is protected from flooding by a ring levee surrounding the plant. The treatment plant flooded during the Great Flood of 1993, causing most of the metropolitan area to be without drinking water for nearly two weeks and resulting in millions of dollars of damages to the facility. Following the disastrous flood, the Des Moines Water Works improved the levee by substantially increasing the height of the levee and installing additional closure structures.

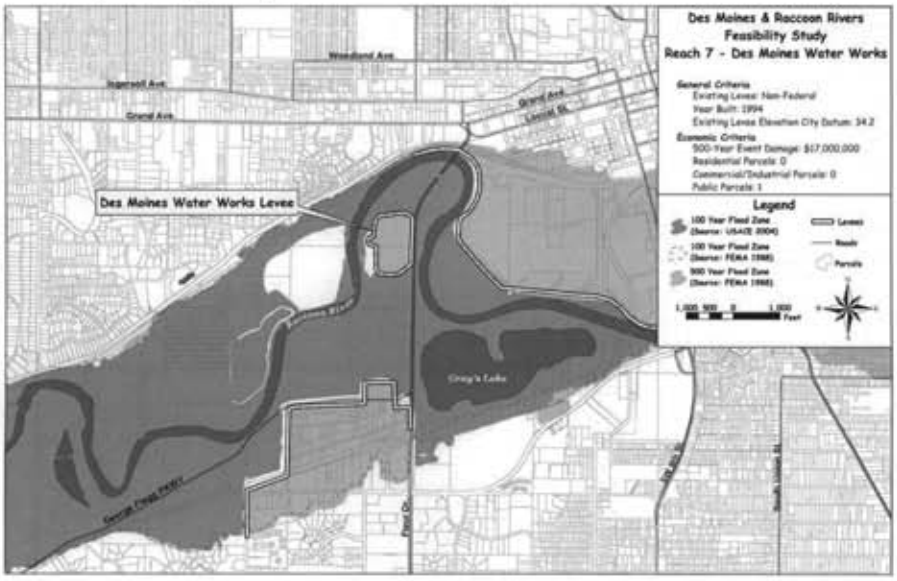

Figure 17: Reach 7 Des Moines Water Works Study Area

As a result of the hydrologic and hydraulic analyses completed in Phase 1 of the study, it was determined that the estimated flood profiles have increased approximately one foot since the time the existing levee was designed. Despite this increase, the levee is believed to be in good condition and provides a high level of flood protection. Currently, the top of the improved levee is about one foot higher than any of the existing Des Moines levee systems, giving it the capability to withstand a slightly more than a 250-year

flood event. During the course of this study, the design team did not evaluate the structural integrity of the system to withstand significant flood events.

The Des Moines Water Works did determine that areas within the ring levee get soft and saturated during a major flood. This can be caused by under-seepage that results from pervious layers of earth material. Another cause could be utility penetrations that allow piping or seepage along the utility. To evaluate structural integrity of the levee and its foundation, a series of soil borings, utility search, and other construction records are required. A follow-on assessment and analysis of the system could then be undertaken. It is recommended the City pursue this type of engineering analysis by requesting a USACE PL 84-99 eligibility inspection. If the levee meets minimum requirements, it can be allowed into the PL 84-99 program and receive annual inspections, flood fighting assistance, and repair due to flood damages. The inspection report would include an analysis of the system and identify any potential deficiencies.

The Des Moines Water Works is located inside Waterworks Park and adjacent to extensive recreation facilities located at Gray's Lake. There are no recreation facilities on the levee and none would be allowed or appropriate due to operational and security considerations.

The Phase I Environmental Site Assessment found no recognized environmental conditions for this location. As a result, no further investigations were conducted.

Because the existing levee provides a high and reliable level of protection, it is expected that future flood damages would be limited. No substantial changes in environmental or cultural conditions are expected.

Non-structural measures were eliminated from consideration, because structures in this reach are protected by the existing levee. It is not necessary or economically feasible to relocate, raise, or flood proof the structures. Channel conveyance in the Raccoon River is severely limited by bridges and other structures in the floodplain, and modification of the channel to increase conveyance is not economically feasible. Raising the height of the existing levee was determined to be not economically feasible. Based on this evaluation, there are no economically feasible flood damage reduction alternatives that can be applied to Reach 7, Des Moines Water Works Levee. The "No Action" alternative was selected for this reach.

4. L. REACH 8 – WEST DES MOINES LEVEE EVALUATION

The West Des Moines–Des Moines Local Flood Protection Project levee system provides protection to the west bank floodplain areas of Walnut Creek and north bank floodplain areas of the Raccoon River upstream of Walnut Creek, as shown on Plate 9, Volume 3 and in Figure 18 below. This system, which protects 900 acres of commercial, residential, and industrial properties in the Cities of Des Moines and West Des Moines, was completed in 1999. Reach 8 contains 904 residential parcels, 227 commercial or industrial properties, and 11 public properties. This area experienced extensive flooding in 1993. The levee system is composed of earthen levees, floodwalls, gated storm sewer outlets, pump stations, ponding areas, and road and railroad closures structures. In the fall of 1993, construction began on the first of four stages of the levee system, with completion in 1999. The overall levee system now provides slightly more than 100-year protection from Raccoon River and Walnut Creek flooding and would have protected the area during the 1993 flood.

Even though the revised modeling (Volume 2, Appendix A), shows the 100-year flood profile of the Raccoon River along the West Des Moines levee as two feet higher than the 1988 Flood Insurance Study (FIS), the levee still provides slightly more than 100-year level of protection.

The levee includes a recreation trail on the levee top, with extensive recreation features protected by the project. Demand for recreational facilities on the levee is strong and is expected to continue to increase. No substantial changes in environmental or cultural conditions are expected.

The Phase I Environmental Site Assessment found no recognized environmental conditions for this location. As a result, no further investigations were conducted. A wetland was identified along the southern edge of the existing levee, although wetland delineation was not performed to determine the boundaries and potential impacts. No cultural resources were investigated as part of this study.

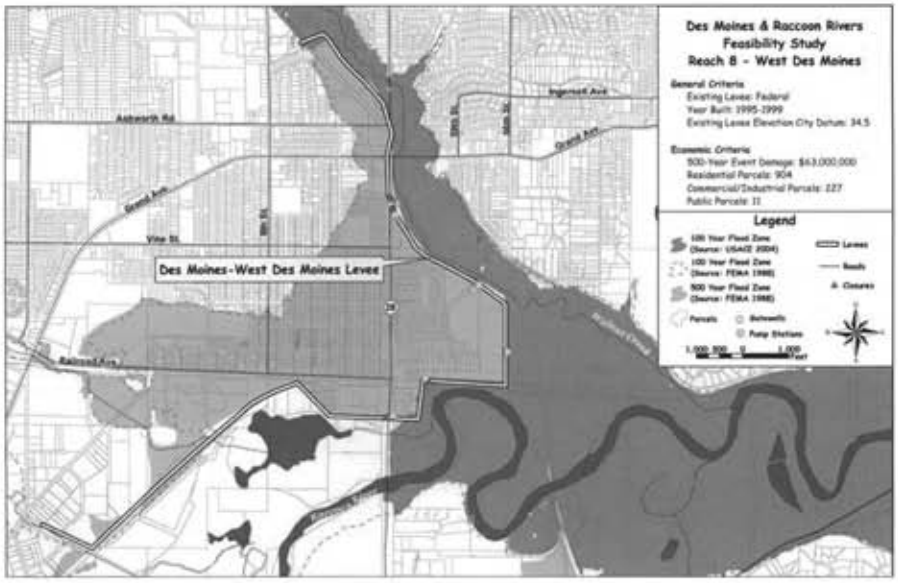

Figure 18: Reach 8 West Des Moines Study Area

Non-structural measures were eliminated from consideration, because structures in this reach are protected by the existing levee. It is not necessary or economically feasible to relocate, raise, or flood proof the structures. Channel conveyance in the Raccoon River is severely limited by bridges and other structures in the floodplain, and modification of the channel to increase conveyance is not economically feasible. An alternative to raise the height of the existing levee was conceptually developed, but was determined to be not economically feasible. Based on this evaluation, there are no economically feasible flood damage reduction alternatives that can be applied to Reach 8. The "No Action" alternative was selected as the final plan.

4. M. REACH 9 - WALNUT CREEK EVALUATION

Walnut Creek is a tributary to the Raccoon River and is subject to flooding as water levels increase on the Raccoon River. The westerly side of the creek is protected by the West Des Moines levee system, leaving the easterly side susceptible.

4.M.1. Existing Conditions (Walnut Creek)

Walnut Creek flows through a rapidly developing 84-square-mile watershed located west of the City in the western suburbs and Dallas County. The creek has experienced flash flooding on numerous

occasions, including 1973, 1986, 1990, 1993, 1997, and 1998. The recently completed Corps of Engineers' West Des Moines – Des Moines Local Flood Protection Project provides comprehensive flood protection to the developed western right bank floodplain areas near the creek's confluence with the Raccoon River. The study area of concern is the unprotected developed floodplain area located on the east bank of the creek near Grand Avenue in the City (Figure 19). The 100-year floodplain in this area from 64th and Center Streets downstream to North Valley Drive contains several residences and businesses that have experienced frequent flooding. The existing ALERT flood warning system provides advance warning to the City and allows residents some additional time to prepare.

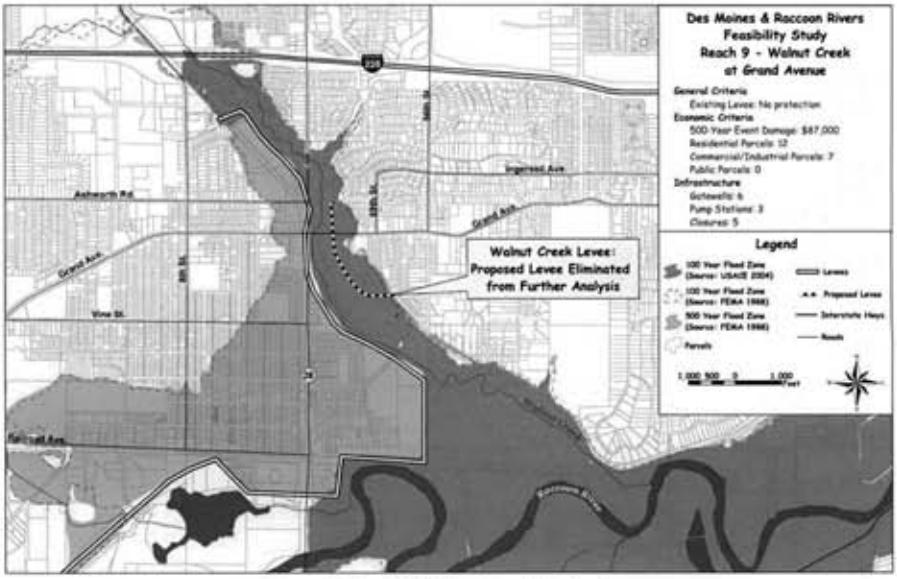

Figure 19: Reach 9 Walnut Creek Study Area

There are no recreation facilities near Reach 9. A multi-use recreation trail, the Bill Riley Trail, is proposed to run along Walnut Creek to Water Works Park terminating at the Great Western Trail on the south side of the Raccoon River. The Phase I Environmental Site Assessment found no recognized environmental conditions for this location. As a result, no further investigations were conducted.

Portions of the Reach 9 area are forested, and wetlands were found to be scattered within that area. No wetland delineation was performed to determine acreages of potential impacts. No cultural resources were investigated.

4.M.2. Future without Project Conditions (Walnut Creek)

Continued urbanization in the Walnut Creek watershed would moderately increase the discharge-frequency values, and flood damages are likely to increase. Structures would continue to be damaged by flash flooding, and further development of affected properties is unlikely. Because the flood profiles used for regulatory purposes have been developed based on complete development of the watershed, additional flood-prone development within the floodplain is unlikely.

4.M.3. Problems and Opportunities (Walnut Creek)

Problem: Approximately 12 homes and 7 businesses are located within the floodplain along Walnut Creek in the Reach 9 study area. Some of these structures are subject to frequent flooding from flash floods, although the depth of the flooding has typically been relatively shallow.

Opportunity: There is an opportunity to develop a recreation trail along Walnut Creek as part of the City's trail master plan.

4.M.4. Selecting and Combining Measures into Alternatives (Walnut Creek)

A levee alignment along the eastern bank of Walnut Creek was selected for evaluation, as discussed in Section VIII of Appendix C and shown on drawings WC-1 to WC-10 in Volume 3. No other levee alternatives were found to be feasible. The levee was designed at the same height as the existing levee and floodwall system on the western bank of Walnut Creek. Levee alternatives higher or lower than the levee on the western bank were considered unlikely to be either cost effective or acceptable to the community.

The proposed alignment begins at the southern end of Reach 9 by tying the levee into high ground behind residences on the west side of 58th Street north of Terrace Drive and continues northward until terminating at high ground behind residences on the north side of Walnut Hill Avenue. This proposal includes approximately 1,620 feet of levee, 780 feet of concrete floodwall, 2,150 feet of relocated sanitary sewer, 140 feet of relocated storm sewer, gate closure structures and gatewells. Real estate concerns may necessitate increasing the overall length of floodwall southward from station 11 + 78. This would result in a corresponding decrease in the length of the levee. If necessary, the increased use of floodwall would result in an increase in the project cost.

The proposed alignment requires the partial closure of 62nd Street between Grand Avenue and Walnut Hill Avenue. This closure would include approximately 200 feet of roadway at the north end of the block. Access from Grand Avenue to existing businesses on both sides of 62nd Street would be maintained via 62nd Street, while access for residences on Walnut Hill Avenue would be maintained via 61st Avenue.

4.M.5. Screening of Alternative (Walnut Creek)

As indicated in Table 21, the estimated cost of the levee alternative is $2,481,000. The estimated total annual costs exceed the total annual benefits resulting in a benefit/cost ratio well below one, therefore indicating that a federal project is not economically feasible. No further alternatives were evaluated. See Appendix B, *Economic Analysis* of the main report for more information about economic evaluation of the alternative.

Table 21: Walnut Creek Cost Benefit Evaluation (May 2004 price level)

Reach 9 Walnut Creek	Project Cost Estimate	Total First Costs	Annualized First Costs	Annual O & M Costs	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits
100 year levee	2,481,000	2,624,000	158,000	0	158,000	50,000	0.32	-11,000

5-5/8% Discount Rate, 50-Year Evaluation Period

4.M.6. Final Plan (Walnut Creek)

The "No Action" alternative was selected. There are no economically beneficial flood damage reduction measures that can be implemented for Reach 9.

4. N. REACH 10 - FOURMILE CREEK EVALUATION

Fourmile Creek is a 121-square-mile watershed that starts in southern Boone County and drains much of north-central Polk County north of Des Moines, including the communities of Alleman, Ankeny, Altoona, and Pleasant Hill, see Figure 20. The basin is about 28 miles long and 4 miles wide. The stream flows south through the eastern part of Des Moines to its confluence with the Des Moines River. The Fourmile Creek floodplain contains over 225 structures including houses, mobile homes, and businesses that are dispersed at several locations along the stream.

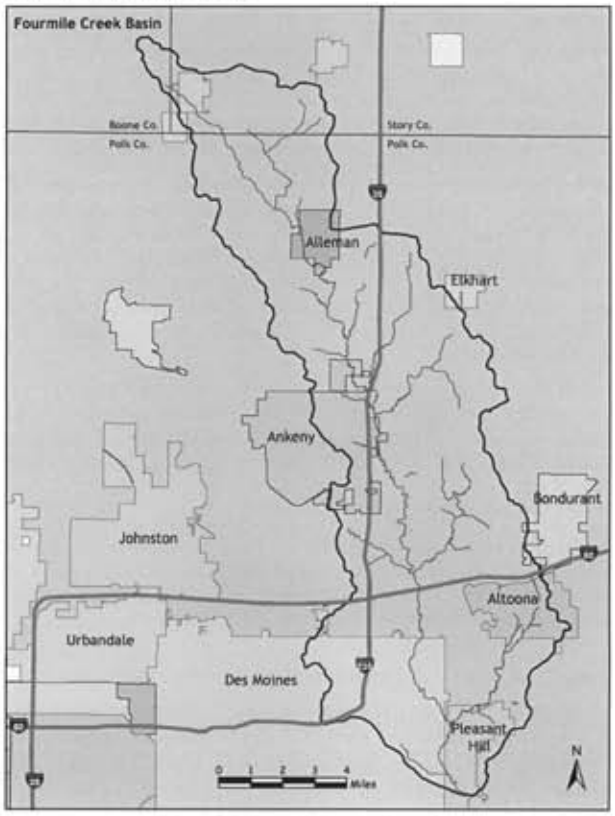

Figure 20: Fourmile Creek Watershed

The USACE completed a flood damage reduction study on Fourmile Creek in May 1975. This report looked at alternatives for providing flood protection along the creek, including upstream reservoirs and several levee alignments, however no justifiable economic alternatives were found. The data, findings and conclusions of the May 1975 study were reevaluated by the study team based upon Fourmile Creek flood profiles from Phase I of this study, current topography mapping, and current housing/business development information.

4.N.1. Existing Conditions (Fourmile Creek)

Fourmile Creek has a heavy growth of trees and brush along most of the creek channel. Some portions of the channel have been straightened between Scott Avenue and the Des Moines River and between Easton Boulevard and Hubbell Avenue. A map of the Fourmile Creek floodplain along Reach 10 is shown on Figure 21. The channel averages 40 to 50 feet wide and 5 to 7 feet in depth.

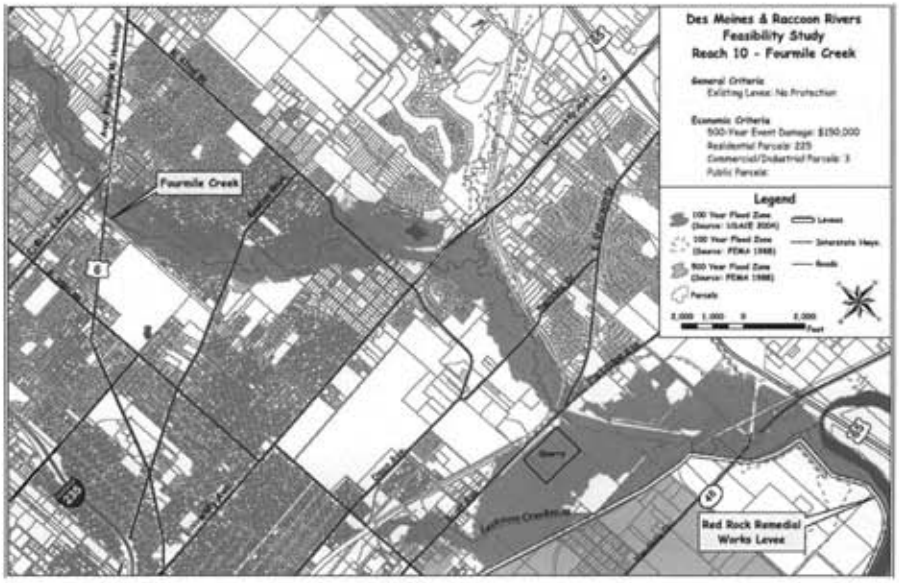

Figure 21: Reach 10 Fourmile Creek Study Area

Many of the areas along Fourmile Creek were developed prior to the era of regulated flood plain development. This development has occurred on both sides of the creek, resulting in a large number of structures that have been subject to repeated flooding. The most intensive area of development is from East Aurora Avenue downstream to East University Avenue. The area has experienced frequent flash flooding, with flood damages occurring on at least twelve occasions since 1947. The most recent flooding on May 23, 2004 was only slightly lower than the record flood crest on June 18, 1998. The 2004 flood was determined to be less than a 4 percent annual chance (25-year) flood event, but caused an estimated $500,000 in damages. Due to the severe flooding, Polk County was declared a federal disaster area in June 2004.

Flood discharge-frequency values for Fourmile Creek were determined using hydrologic models of the watershed as discussed in Appendix A, Volume 2. Because the drainage area for Fourmile Creek is small enough to be impacted by urbanization, both the existing conditions and future conditions were modeled. The future conditions discharges were prepared based on guidance from Federal Emergency Management Agency (FEMA) and were estimated based on year 2020 growth projections from the communities in the watershed. This analysis found that the projected development in the watershed could increase future flood discharges by about 12 to 13 percent as shown in Table 22.

Table 22: Comparison of Fourmile Creek Discharges

Year	Exceedance Probability	Existing CFS	Future CFS	% Increase
2	0.5	2,330	2,780	19%
5	0.2	3,820	4,470	17%
10	0.1	4,870	5,640	16%
25	0.04	6,230	7,140	15%
50	0.02	7,260	8,260	14%
100	0.01	8,290	9,380	13%
250	0.004	9,650	10,850	12%
500	0.002	10,700	12,000	12%

Because the existing conditions discharges are higher than those used in the July 1988 Flood Insurance Study, the estimated 1 percent annual chance (100-year) flood profile increased up to three feet. The largest increases are downstream of Euclid Avenue to Easton Boulevard. The updated flood profiles are shown on Plates A12 to A16 in Volume 3. Flood inundation maps of the Fourmile Creek floodplain were prepared based on the existing conditions flood profiles.

There are no structural flood protection facilities to protect properties along Fourmile Creek, except along the lower portion near the confluence with the Des Moines River. The Red Rock Remedial Works Levee was constructed along the west bank to prevent flooding of commercial and industrial properties in this area.

The flash flooding nature of Fourmile Creek allows for very little response time to flooding events. The City's ALERT flood-warning system increases the warning time to allow additional time to evacuate people from the flood area. However, the flashy nature of the stream does not allow adequate response time to protect property, resulting in repeated property damage from flooding.

Flood damage along Fourmile Creek is caused by overbank flooding. Over 1,200 acres would be inundated by the 1 percent annual chance (100-year) flood. Approximately 225 residences, 135 of which are mobile homes in two parks, and three businesses are contained in the Fourmile Creek floodplain. The mobile home park just south of Hubbell Avenue is particularly at risk of severe flooding.

In some cases, it is impractical to protect structures from flooding; removal of the structures from the floodplain is the best alternative. The City has an ongoing floodplain property buyout program to purchase frequently damaged structures in unprotected areas. This program has been very successfully in reducing flood damage by the removal of many of the most flood-prone structures.

The City has undertaken an effort, in cooperation with FEMA, to relocate residents and remove several flood-prone structures from the floodplain in the Williams Street area. Because some residents have elected to remain in their homes, some portions of the floodplain are a patchwork of scattered homes and vacant properties. Properties that are part of the buy-out program are being reformed into green space or small parks. Buyouts of the mobile home parks have not been performed since mobile home parks are considered commercial properties and the funds used for the FEMA buyout program are prioritized for residential properties.

The Gay Lea Wilson Trail is a multi-use trail currently connecting east Des Moines with Pleasant Hill and Altoona. From a hub off University Avenue, at the Copper Creek shopping center in Pleasant Hill, one segment runs northeast for about four miles to Altoona, a second segment runs south for about two miles to Scott Avenue and a third segment runs northwest into Des Moines terminating at Easton Boulevard. The length of the third segment is approximately 1.5 miles with an asphalt surface and a width of 10 feet. Trailheads are located at Easton Boulevard at Fourmile Creek and the parking lot at E 42nd Street and

Washington Avenue. A map of the City's recreational trail facilities is shown on Plate 12 in Volume 3. The trails are frequently used, and use is steadily increasing.

The Phase I Environmental Site Assessment found no recognized environmental conditions for this location. As a result, no further investigations were conducted.

A site visit to the Fourmile Creek area did not result in the identification of any sensitive environmental resources that would have been impacted, although no detailed analysis was prepared. No cultural resources were investigated.

4.N.2. Future without Project Conditions (Fourmile Creek)

Urbanization would continue to moderately increase the discharge-frequency relationships in the Fourmile Creek drainage. Structures would continue to be damaged by flooding, and further development of affected properties is unlikely. Additional buyouts and relocations of homes from the floodplain are likely. The recreational opportunities would likely improve as additional green space becomes available and as demand for recreational opportunities continues to grow.

4.N.3. Problems and Opportunities (Fourmile Creek)

Problem: Properties along Fourmile Creek are subject to frequent flooding from flash flood events. Flood damages are not confined to a concentrated area, but are scattered along the length of the stream.

Opportunities: As structures are removed from the Fourmile Creek floodplain, there is an opportunity for increased recreational use and green space. Construction of levees would provide opportunities for increased trail development along Fourmile Creek.

4.N.4. Selecting and Combining Measures into Alternatives (Fourmile Creek)

During the 1975 feasibility study, levees to protect selected areas along the stream were evaluated and found to be not feasible. The study team updated some of these levee alignments to reflect existing conditions and reevaluated the levees. Four of the alignments evaluated in the 1975 study (Levees RB-1, RB-2, LB-1, and LB-3), were eliminated because they severely encroached into the floodway, causing the 1 percent annual chance (100-year) flood profile to rise more than one foot and unacceptably impacting adjacent properties. Three of the four levee alignments eliminated, RB-1, RB-2 and LB-1, would provide protection to very few structures; however LB-3 would provide protection to a flood-prone mobile home park containing approximately 105 units, just south of Hubbell Avenue. The alignment of LB-3 would, however, encroaches into the floodway and would require the removal of all the mobile home units adjacent to Fourmile Creek. The locations of these levee alignments are shown on Drawings FMC1 to FMC11 in Volume 3. Six levee alignment alternatives, as described below, were evaluated:

LB-2, E. 38th Street to Fourmile Drive, left bank, LB-2, 2,250 ft levee

LB-4, Douglas Street to E. 38th Street, left bank, 7,000 ft levee

RB-3, E. 33rd St. to E. 35th St. north of Easton Avenue, right bank, 3,900 ft levee

RB-4, Hubbell Avenue at E. 32nd Court, right bank, 800 ft levee

RB-5, E. Euclid Avenue at E. 33rd Street, right bank, 1,000 ft levee

RB-6, Colfax Avenue at Shawnee Avenue, right bank, 2,250 ft levee

Because a levee to protect the mobile home (MH) park south of Hubbell Avenue was not feasible, a buyout of the park was evaluated. Buyouts of selected high-risk homes in the Fourmile Creek floodplain were also considered. Preliminary evaluation indicated that costs to remove these structures from the floodplain would far exceed the estimated flood damage reduction benefits; therefore, this alternative was

not selected for further consideration. A buyout of the mobile home park was determined to be the flood damage reduction alternative most likely to be feasible for this area.

4.N.5. Screening of Alternatives (Fourmile Creek)

A summary of the estimated costs and benefits for each of the alternatives is shown in Table 23. As shown in this table, the estimated annual costs are much greater than the annual benefits and the benefit cost ratios for each alternative are substantially less than one. Based on this analysis, all the alternatives were eliminated from further consideration. Detailed information about the economic analysis is included in Appendix B.

4.N.6. Final Plan (Fourmile Creek)

The "No Action" alternative was selected. There are no economically feasible flood damage reduction alternatives for Reach 10, Fourmile Creek. Continued buyouts of flood prone structures in the floodplain by the City are likely to continue and would help to reduce future flood damages.

Table 23: Fourmile Creek Economic Evaluation Summary (May 04 price level) [1]

Alternatives	Project Cost Est.	Annualized First Costs	Annual O & M Costs	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits
Reach LB-2	3,790,000	241,000	3,100	244,000	13,000	0.06	-230,000
Reach LB-4	2,690,000	171,000	3,000	174,000	12,000	0.07	-162,000
Reach RB-3	571,000	36,000	1,000	37,000	1,000	0.03	-36,000
Reach RB-4 & 5	1,420,000	90,000	2,000	92,000	0	0.00	-92.000
Reach RB-6	165,000	10,000	1,000	11,000	1,000	0.10	-10,000
MH Park Buyout	2,150,000	147,000	0	147,000	47,000	0.32	-99,000
No Action	0	0	0	0	0	0	0

[1] 5-5/8% Discount Rate, 50-year Evaluation Period

4. O. REACH 11 – LEETOWN CREEKWAY EVALUATION

Leetown Creekway (formerly known as 7th Ward Ditch) is within a 9-square-mile drainage area on the east side of the City, which drains into Fourmile Creek south of Scott Avenue. The Reach 11 area is shown on Plate 11 14, Volume 3 and below, in Figure 22.

4.O.1. Existing Conditions (Leetown Creekway)

Since the 1980s, the City has constructed several storm water detention basins to reduce flood flows, as well as channel and storm sewer improvements to improve the capacity of the system. Downstream of Easton Boulevard, Leetown Creekway flows through a storm sewer system that goes under the western edge of the Iowa State Fairgrounds.

The storm sewer emerges just past East 30th Street and Dean Avenue and combines with other storm sewers into an open channel. The channel flows approximately 2 miles across low-lying properties to its confluence with Fourmile Creek. This area is in the Fourmile Creek floodplain and experiences poor drainage and frequent flooding.

Despite the numerous improvements to the storm sewer system, homes and businesses near the southwest corner of the fairgrounds (E. 30th Street and Dean Avenue) continue to experience frequent flooding from

water backing up through the storm sewer system. Homes and businesses along the stream down to Scott Avenue also experience flooding.

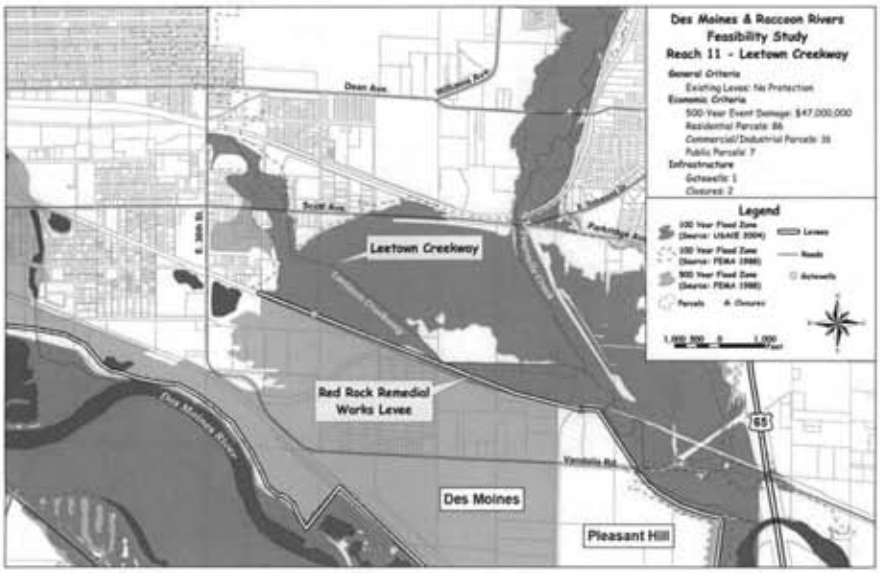

Figure 22: Reach 11 Leetown Creekway Study Area

There is no structural flood protection along Leetown Creekway. A floodplain buyout program has existed since the late 1990s and several structures near the intersection of 30th Street and Dean Avenue have been purchased and removed. The Red Rock Remedial Works Levee was constructed along the lower portion of Leetown Creekway and Fourmile Creek to prevent flooding of commercial and industrial properties in this area from Lake Red Rock. No recreation facilities were identified or are planned for the Leetown Creekway area..

The Phase I Environmental Site Assessment found no recognized environmental conditions for this location. As a result, no further investigations were conducted.

No environmental or cultural resources were investigated; however a database search revealed one cultural resource site within 100 yards of the study area.

Leetown Creekway area has 86 residential properties, 16 commercial or industrial properties and 7 public properties within the 500-year floodplain. Many structures within the 100-year floodplain that had been subject to frequent flooding have been removed.

4.O.2. Future without Project Conditions (Leetown Creekway)

Urbanization would likely increase in the upper portions of the watershed and possibly causing increased flood discharges. Structures would continue to be damaged by flooding and further development of affected properties is unlikely.

4.O.3. Problems and Opportunities (Leetown Creekway)

Problem: The low-lying areas near East 30th Street contain single-family residences that experience frequent flooding caused by a combination of inadequate storm-sewer capacity, inadequate channel capacity, and backwater from flooding in Fourmile Creek. Flooding caused by inadequate storm sewer capacity must be addressed locally, rather than as part of a Federal project.

Opportunities: There are no opportunities to improve recreation as part of a Federal project, due to the existing urban land uses.

4.O.4. Measures Eliminated From Further Analysis (Leetown Creekway)

Levees along Leetown Creekway were eliminated from consideration. Flood-prone structures in this area are located very close to the stream and there is inadequate room to construct a levee. A floodwall could be constructed in some areas, but the cost would be prohibitive for the relatively small number of structures that could be protected.

4.O.5. Selecting and Combining Measures into Alternatives (Leetown Creekway)

An alternative was initially developed for providing flood protection in the Leetown Creekway area by preventing Fourmile Creek floodwaters from backing up into the Leetown Creekway floodplain. This would reduce the flood stages in Leetown Creekway and, to a lesser extent, increase the capacity of the storm sewer systems draining into Leetown Creekway.

A levee would be constructed from the Red Rock Remedial Works Levee to high ground on the north side of Leetown Creekway along Scott Avenue. Storm water in Leetown Creekway would be diverted into a local quarry when Fourmile Creek was flooding that would in turn be pumped over the levee into Fourmile Creek. The plan would require the City to acquire flood easements to allow the City to store stormwater in the quarry.

It was initially believed that this alternative would also provide increased flood protection for commercial and industrial structures protected by the Red Rock Remedial Works Levee. When it was discovered that this alternative would not increase the level of protection for the Red Rock Remedial Works area, it was eliminated from further consideration due to its high cost and relatively low level of flood damages that could be prevented. The Red Rock Remedial Works Levee provides a high and reliable level of protection to the structures within its protected area.

4.O.6. Final Plan (Leetown Creekway)

The "No Action" alternative was selected. There are no economically feasible flood damage reduction measures, which could be implemented for Reach-11, Leetown Creekway. Continued buyouts of flood prone structures in the floodplain by the City are likely to continue and would help to reduce future flood damages.

5. DESCRIPTION OF RECOMMENDED PLAN

As discussed in Section 4, alternatives were evaluated for each reach resulting in the identification of a recommended plan for each reach. These recommended plans for each reach have been combined into a single recommended plan for a project as described below:

5. A. PLAN COMPONENTS

5.A.1. Reach 1, Birdland Park

Project Levee Features

- Reconstruct 7,700 feet of levee to 500-year level side slope is 3 to 1 with a 10' to 15' crown width.
- Closures at Saylor Road, (hinged steel gate)
- Retaining wall at Birdland Park's parking area (440 ft long)
- 42" RCP drainage pipe and gatewell for Riverview Park Lagoon
- Several utilities would be relocated
- Reconstruct existing asphalt bike trail on levee (10 ft wide 2,900 Ft long)

Project Recreational Features

- Construct a multipurpose recreational trail from the Neal Smith Trail to Riverview and McHenry Parks (12 ft wide 2,200 ft long)
- Landscaping on the section of levee crossing Riverview Park.

Unavoidable Environmental Impacts and Mitigation Plan

- Between 1.4 to 2.3 acres of emergent wetlands would be impacted. Mitigation at Chichaqua would be between 2.8 to 4.6 acres of emergent wetlands restored.
- Approximately 0.2 acres of bottomland forest would be impacted. Mitigation at the Central Place Riverside of levee would be 0.4 acres.
- Between 2.7 to 3.8 acres of open water would be impacted. Mitigation at the Chichaqua site would be between 2.7 to 3.8 acres of open water.
- Approximately 1.4 acres of upland forest would be impacted. Mitigation at Chichaqua will be 2.6 acres of upland forest.

a) Real Estate Estimates

	Birdland Park Reach	Acres	Acres
Non-Creditable	Existing Levee Right of Way	26.47	
	Sub Totals →		26.47
Creditable	Temporary Work Areas Easement	3.22	
Creditable	Temporary Borrow Area Easement	2	
Creditable	Fee Mitigation	17.38	
Creditable	Fee (Additional Right-of-way)	0.5	
	Sub Totals →		23.1
	Total acres needed for the project		49.57

5.A.2. Reach 2, Central Place

Project Features

- Reconstruct approximately 5,900 feet of levee to 500-year level
- Construct outlet pipes and gatewells from 3 existing pump stations

Unavoidable Environmental Impacts and Mitigation Plan

- Approximately 1.2 acres of bottomland forest would be impacted. Mitigation would be 2.2 acres onsite, riverside of the levee.
- Approximately 3.2 acres of upland forest would be impacted. Mitigation would be 2.2 acres at Central Place riverside of the levee and 3.8 acres at Chichaqua.

Real Estate Estimates

- Fee Mitigation (15.09 acres)
- Flood Protection Levee Easement (0.1 acres)
- Temporary Borrow Area Easement (0.5 acres)

5.A.3. Reach 3, Downtown East Closures

Project Features

- Four permanent closures; DM 41, DM 51, DM 85 and I-235 Embankment
- Six reduced closures widths; DM 45, DM 73, DM 75, DM 79, DM 81, and DM 87
- Install gates at existing pedestrian walkway closures at Simon Estes Amphitheater

Real Estate Estimates

- All lands are part of the existing right of way and are not creditable.

5.A.4. Reach 4, Downtown West Closures

Project Features

- One permanent closure DM86
- Five reduced closures width; DM 76, DM 78, DM 80, DM 82, and DM 88

Real Estate Estimates

- All lands are part of the existing right of way and are not creditable.

5.A.5. Reach 5, Downtown South Closures

Project Features

- Two permanent closures DM 36, and DM 42

Real Estate Estimates

- All lands are part of the existing right of way and are not creditable.

5. B. FINAL BENEFITS AND COSTS

A detailed cost estimate, referred to as a baseline or MCACES cost estimate, was prepared based on May 2004 price levels in order to accurately define the project costs. See Appendix D for the Cost Engineering breakouts prepared for the cost of implementing the recommended plan. These cost estimates have been indexed to October 2005 price levels in accordance with Engineer Manual 1110-2-1304. The total cost of the recommended multipurpose project, presented in October 2005 dollars, is $10,491,000 as shown in Table 24. A summary of project costs and benefits is shown in Table 25. It is important to note that the cost estimate will increase when the project is implemented due to higher

construction costs in the future. Accordingly, the recommended plan costs have been inflated to arrive at a "fully funded" construction cost estimate of $10,924,000 as shown in Table 24.

The net annual benefits for the project are $1,137,000. To reduce project costs where possible and to minimize the social effects wherever practical, designs will be refined during plans and specification in coordination with the landowners and the City Officials. After additional topography and soils data is available, the Study Team would work closely with the affected landowners and the City Officials to minimize the social effects and reduce overall/net project costs.

Table 24: MCACES Summary of Cost Estimates for the Recommended Plan (Oct 2005 Price Level)

	Project Cost Est. (without inflation) Flood Damage Reduction	Project Cost Est. (without inflation) Recreation	Fully Funded Est. (incl. inflation) Flood Damage Reduction	Fully Funded Est. (incl. inflation) Recreation
Birdland Park 500-year Levee Reconstruction				
Lands and Damages	655,000		655,000	
Relocations	123,000		131,000	
Levees and Floodwalls	3,557,000		3,745,000	
Planning, Engineering, Design	554,000		546,000	
Construction Management	332,000		349,000	
Sub Total	5,221,000		5,426,000	
Birdland Park Recreation Multi-purpose Trail				
Recreational Facilities		204,000		216,000
Planning, Engineering, Design		31,000		31,000
Construction Management		19,000		19,000
Sub Total		254,000		266,000
Central Place 500-Year Levee Reconstruction				
Lands and Damages	164,000		164,000	
Levees and Floodwalls	2,127,000		2,239,000	
Pump Stations	989,000		1,050,000	
Planning, Engineering, Design	470,000		464,000	
Construction Management	282,000		296,000	
Sub Total	4,032,000		4,213,000	
Downtown East Levee Closures Improvements				
Lands and Damages	9,000		9,000	
Levees and Floodwalls	470,000		495,000	
Planning, Engineering, Design	141,000		140,000	
Construction Management	58,000		59,000	
Sub Totals	678,000		703,000	
Downtown West Levee Closures Improvements				
Lands and Damages	9,000		9,000	
Levees and Floodwalls	187,000		196,000	
Plans and Engineering Design	56,000		55,000	
Construction Management	22,000		24,000	
Sub Totals	274,000		284,000	
Downtown South levee Closures Improvements				
Lands and Damages	8,000		8,000	
Levees and Floodwalls	17,000		17,000	
Plans and Engineering Design	5,000		5,000	
Construction Management	2,000		2,000	
Sub Totals	32,000		32,000	
FDR and Recration Totals	10,237,000	254,000	10,658,000	266,000
Recommended Plan Total	**10,491,000**		**10,924,000**	

Table 25: Summary of Cost and Benefits for all the Project Components (Oct 2005 Price Level)

	Project Cost Estimate	Interest During Const.	Total First Costs	Annualized First Costs	Annual O & M Costs	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits	Residual Annual Flood Damages
Birdland Park 500 year Levee	5,221,000	416,000	5,637,000	315,000	14,000	329,000	458,000	1.4	129,000	11,000
Central Place 500 year Levee	4,032,000	273,000	4,305,000	240,000	15,000	255,000	938,000	3.7	683,000	8,000
Downtown East Closure Improvements	678,000	35,000	713,000	40,000	0	40,000	163,000	4.1	123,000	264,000
Downtown West Closure Improvements	274,000	14,000	288,000	16,000	0	16,000	77,000	4.8	61,000	167,000
Downtown South Closure Improvements	32,000	2,000	34,000	2,000	0	2,000	31,000	16.5	29,000	48,000
Flood Damage Reduction Totals	10,237,000	740,000	10,977,000	613,000	29,000	642,000	1,667,000	2.6	1,025,000	498,000
Birdland Park Recreation Trail	254,000	15,000	269,000	15,000	1,000	16,000	127,000	7.9	111,000	N/A
Totals	10,491,000	755,000	11,246,000	628,000	30,000	658,000	1,794,000	2.7	1,136,000	498,000

5-1/8% Discount Rate, 50-Year Evaluation Period

Table 26: Deleted

5. C. OPERATION AND MAINTENANCE

The City of Des Moines will operate and maintain the project in accordance with the procedures and schedules set forth in an Operation and Maintenance manual that the USACE would prepare and provide. The total estimated annual cost of operation and maintenance for the Recommended Plan is $30,000, which includes both flood control and recreation features. Maintenance would consist of annual inspections of and repairs to the project permanent levees, interior drainage facilities, and recreation facilities. Operation would include the operation of pumping stations and gates and the servicing of all project structures, including landscaping.

Levees would be kept free of brush and tree growth and be mowed several times a year. Rodent holes and other embankment damage would be filled and repaired as needed. See Appendix C for additional information on required operation and maintenance activities.

5. D. PLAN ACCOMPLISHMENTS

Based on public, interagency, and local Sponsor inputs and District evaluations, the social and economic effects of the recommended plan would be positive. Levels of protection for Birdland Park and Central Place would increase from 50-year to as much as 500-year. Improved design for closures would significantly reduce the risk of not completing a closure or having a closure fail, which has been the case in recent flood events. The environmental effects of the recommended plan would be negative due to the filling of wetlands and open water and clearing of upland and wetland forests. Compensatory mitigation is proposed to offset the environmental impacts. Recreational opportunities would be met by improving the existing trail network between parks and natural areas. By far, the most important effect of implementation of the recommended plan would be that hundreds of homes, businesses, and public structures would be reliably protected from future floods. It is important to note that the economic analysis done as part of this study claims only national economic benefits from flood damage reduction and recreation. The residual damages for the modified project in average annual dollars and as a percentage of the without-project average annual flood damages can be found in the chart below.

	Without Project Average Annual Flood Damages	Flood Damage Reduction Annual Benefits	Residual Annual Damages	% Damages Reduced
Birdland Park	418,500	407,300	11,200	97%
Central Place	897,100	888,800	8,300	99%
Downtown East	427,000	163,300	263,700	38%
Downtown West	243,900	76,700	167,200	31%
Downtown South	79,400	31,300	48,100	39%
Oct 05 prices, 5-1/8% discount Rate, 50-year evaluation period				

The recommended project would provide many long-term local and regional economic benefits that are not incorporated into the economic benefits attributed to the recommended plan, but which are very real and important to the community and its residents. These include improved community cohesion, preserved and improved property values and local tax base, enhanced recreation opportunities, improved public health and safety, and enhanced community growth and development opportunities.

An Environmental Assessment has been prepared to assess the impacts of the recommended project and obtain public and interagency comments. The Environmental Assessment is integrated in this document. Any change to project plan formulations that may affect environmental and social acceptability would be fully re-coordinated with the public, other agencies and the local Sponsor during the development of final plans and specifications.

5. E. SUMMARY OF ECONOMIC, SOCIAL AND ENVIRONMENTAL EFFECTS

In reviewing the planning objectives developed for the Des Moines and Raccoon Rivers Feasibility Study outline earlier in this report, all objectives were met in formulation of the recommended plan. Problem areas were identified and an array of potential alternatives, both structural and nonstructural, that would alleviate out-of-bank flooding problems within the study area were developed and evaluated. As the recommended plan was identified, coordination with the City took place throughout the study, taking into account the City's goals and input,

5.E.1. National Economic Development (NED)

A plan was formulated which contributes to National Economic Development (NED); i.e. the benefits of the project exceed the project costs. Since the costs and benefits of at least one plan providing greater flood damage reduction (i.e. a larger plan) than the recommended plan is not presented, the report would not adequately demonstrate that the recommended plan is the NED Plan. Therefore, in accordance with

paragraph 4-3b (2)(a) of ER 1105-2-100, the recommended plan should not be labeled as the NED Plan and should be labeled and presented as the recommended and is also the locally preferred plan.

5.E.2. Regional Economic Development (RED)

Regional Economic Development (RED) impacts are expected to be minimal due to FEMA certified flood protection currently in place in project areas. The Recommended Plan for flood damage reduction provides benefits too many areas of the flood threatened community along the Des Moines and Raccoon Rivers.

5.E.3. Other Social Effects (OSE)

Other Social Effects (OSE) addresses concerns in areas where there are potential risks to health, and community cohesion. These risks would continue under the "No Action Plan." The Recommended plan for flood damage reduction reduces the risk for flood-related loss of health issues and other community cohesion concerns. Neither Regional Economic Development nor social effects were significant areas of concern or controversy during the planning and public involvement process.

5.E.4. Environmental

The following Table 27 summarizes effects on the environment from actions of the proposed plan.

Table 27: Summary of Environmental Effects

Types of Resources	Regulatory Authorities	Measurement of Effects
Air quality	Clean Air Act, as amended (42 U.S.C. 165h-7, et seq.)	No significant effect
Areas of particular concern within the coastal zone	Coastal Zone Management Act of 1972, as amended	Not present in planning area
Endangered and threatened species critical habitat	Endangered Species Act of 1973, as amended (16 U.S.C. 1531, et seq.)	No significant impacts anticipated
Fish and wildlife	Fish and Wildlife Coordination Act (16 U.S.C. 661, et seq.)	No significant effect
Floodplains	Executive Order 11988, Flood Plain Management	No significant effect
Historic and cultural properties	National Historic Preservation Act of 1966 as amended (16 U.S.C. 470, et seq.)	No significant effect
Prime and unique farmland	CEQ Memorandum of Aug. 11, 1980; Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing the National Environmental Policy Act	No significant effect
Water quality	Clean Water Act of 1977, as amended (33 U.S.C. 1251, et seq.)	No significant effect
Wetlands	Executive Order 11990, Protection of Wetlands, Clean Water Act of 1977, as amended (43 U.S.C. 1857h-7, et seq.)	No significant effect
Wild and scenic rivers	Wild and Scenic Rivers Act, as amended (16 U.S.C. 1271, et seq.)	Not present in planning area

6. INVENTORY, ANALYSIS, AND STUDY FINDINGS

This inventory and analysis also serves as the existing condition, affected environment and environmental impact analysis in the project area.

6. A. HYDROLOGY AND HYDRAULICS

6.A.1. Floodplain Features and Assumptions

Table 28: Stream/Floodplain Features

Feature	Des Moines	Raccoon	Fourmile	Walnut
Stream length	79,000 feet	45,000 feet	43,637 feet	16,600 feet
Number of cross sections	142	83	85	42
Number of bridges	20	13	12	5
Channel "n"-value	.020-.035	.022-.030	.038-.0475	.032-.035
Overbank "n"-value	.020-.135	.060-.130	.040-.140	.068-.137

6.A.2. Project Impacts

Each proposed alternatives involve raising existing levees and care was taken not to move riverward of the existing levees. Therefore, there are no induced water level increases due to any levee raises or improvements. In fact, the proposed project changes involve making the side slopes of the alternative levees gentler. The net affects of this change would be to increase the cross-sectional area.

The storage behind Birdland Park and Central Place is not large enough to reduce discharges on the Des Moines River. Raising these levees would not create water surface increases due to the reduction in storage volume. During the 1993 Flood, failure of the levees did not result in any noticeable reduction of the flood water levels in the river channel.

6. B. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE MATERIAL

6.B.1. Background

Phase I and Phase IIA Hazardous, Toxic, and Radioactive Waste (HTRW) Environmental Site Assessments for the Des Moines and Raccoon Rivers Flood Damage Reduction Feasibility Study were conducted under contract for the District. Details associated with these reports are summarized in Appendix E.

6.B.2. Conclusions

The HTRW assessments revealed recognized environmental conditions in the following locations: Birdland Park, Central Place (including the local mitigation site), Downtown West, and Downtown East project areas, and the stockpiled material at the Harriet Street Landfill. These conditions were confirmed via Phase IIA sampling, revealing metals and polycyclic aromatic hydrocarbons (PAH) concentrations in excess of the Iowa State Land Recycling Program Standards.

Due to ongoing construction activities at the Downtown West Levee project area, between Center Street and Riverview Park,, no Phase IIA ESA was conducted at this time. However, the Phase I ESA did identify recognized environmental conditions at this location.

This assessment has revealed no evidence of recognized environmental conditions, such as hazardous substances, HTRW, or other regulated contaminants, in connection with the Walnut Creek project area, the Downtown South project area, Leetown Creekway (the 7th Ward Ditch) project area, the Fourmile Creek project area, and the wetland mitigation site.

6.B.3. Recommendations

No further investigation, such as a Phase II ESA, is warranted at Walnut Creek, Downtown South, 7th Ward Ditch, or Fourmile Creek. However, further investigation is warranted at the Downtown West Levee project area, between Center Street and Riverview Park.

The contaminants on the property are not an issue. ER 1165-2-132, *Water Resources Policies and Authorities - Hazardous, Toxic and Radioactive Waste (HTRW) Guidance for Civil Works Projects*, requires coordination with the appropriate stage agency when a non-federal sponsor acquires land that is not contaminant-free. In Iowa, obtaining a No Further Remedial Action Planned (NFRAP) certificate from the Land Recycling Program administered by the Iowa DNR is typically the state process used by landowners. The non-federal-sponsor contacted the Iowa DNR regarding obtaining a NFRAP certificate for this property. The Iowa DNR informed the sponsor (see Appendix E-G-1 of Volume 2) that due to the low level of contaminants, it would not be appropriate to even enter the state Land Recycling Program, which ultimately issues the NFRAP certificate. The non-federal sponsor (City of Des Moines) received a letter from Iowa DNR stating that due to the very low concentrations (slightly elevated heavy metal concentrations were generally within the background levels in the State of Iowa), no further investigation of the site would be required.

All costs related to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulated material will be the sponsor's responsibility in accordance with ER 1165-2-132. Measures will be taken during construction to ensure worker safety if exposed to contaminated material.

6. C. ENVIRONMENTAL, CULTURAL, AND SOCIAL RESOURCES

6.C.1. Alternatives

During Plan Formulation, the following steps were used to develop final plans for flood damage reduction for each reach: 1) identify problems and opportunities; 2) identify planning constraints; 3) identify structural and non-structural flood damage reduction measures, evaluate for effectiveness, and combine effective measures for each reach into alternatives; 4) screen the alternatives against NED, to determine which alternatives for each reach would have the greatest net benefits and a B/C ratio greater than 1.0; and 5) select the final plan for each reach. More detailed information on plan formulation is described in section 4A.

a) Reach 1. Birdland Levee

The existing levee has a high probability of failure due to instability of the levee embankment. Fifty-year old trees and brush, unsuitable construction materials, and steep embankments which are difficult to mow are the major sources of instability. Inability to adequately make road closures during floods increases the potential for flood damage.

There is an opportunity to enhance a portion of the Neal Smith Trail by widening it to improve safety. The City would also like to construct short spurs from the trail to existing ball fields adjacent to the levee. Also, the City wants to construct some rest areas and lookout points along the trail on the levee near Riverview Park to increase enjoyment of the Trail.

The "No Action" alternative means that no Federal flood reduction project would be constructed. This alternative assumes that the community would continue to rely on the existing levee system, emergency flood fighting measures, and flood insurance to provide flood damage protection.

As shown in Figure 5, three alignments were considered.

- Alignment 1 is constructed of both floodwall and levee. The floodwall is required to avoid impacting the existing businesses.
- Alignment 2 traverses over Riverview Park and is an earthen levee with a seepage berm and gated culvert.
- Alignment 3 follows the existing alignment and is an earthen levee with a seepage berm and gated culvert to drain storm water.

In addition, one recreational alternative was developed which is dependent on the construction of Alignment 2. A bike trail would be built from the existing Neal Smith Trail and continue on the levee to McHenry Park and up the hill. Landscaped overburdens with a pedestrian and bike trail down to Riverview Park would be constructed. Overlooks and resting areas could also be part of the bike and pedestrian trail.

Constructing a 25-year or 50-year levee would result in a levee that is lower than the existing levee and would require removing earthen material from the site, which would result in cost greater than flood damage reduction benefits. Therefore, the 25-year and 50-year levees were removed from further consideration.

A major desire of the City is to maximize flood damage reduction at a reasonable cost. After review of the Feasibility Report, Alignment 2 is the Recommended Plan for flood damage reduction. Alignment 2 has not yet been formally selected by the City for implementation.

b) Reach 2. Central Place Levee

The Central Place levee was constructed over a period using different construction methods. Field observations and soil borings indicated that a high variety of fill materials was used with less than optimal compaction, extensive embedded debris, and tree root growth, which could lead to failure during a flood event.

At this time, the City does not plan to extend their bike trail system into this area; therefore, there are limited opportunities for recreation other than maintaining the green space between the levee and the river.

The "No Action" alternative means that flood protection would continue to diminish as trees continue to compromise the levee. Upland and bottomland forests would continue to become more structurally diverse on and adjacent to the existing levee. The existing reed canarygrass areas within the bottomland forest would likely remain for the foreseeable future since it is very difficult for trees or shrubs to seed themselves in areas fully vegetated with reed canarygrass.

The primary alternatives under consideration involve reconstruction of the existing levee to provide improved flood protection to the 500-year level from 2nd Avenue to I-235. The only viable measure to reduce flood damage along Reach 2 is reconstructing the levee; constructing new gatewells, and improving pump station discharge pipes at three elevations, 100-year, 250-year and 500-year.

Two lower levee heights, 25-year and 50-year, were considered and eliminated as the existing levee has enough material for a 250-year height, and the cost to remove the excess material exceeded the economic benefits.

A major desire of the City is to maximize flood damage reduction at a reasonable cost. After review of the Feasibility Report, Alignment 2 is the Recommended Plan for flood damage reduction. Alignment 2 has not yet been formally selected by the City for implementation.

c) Reach 3 – Downtown East Levee

Currently, flood fighting along Reach 3 requires construction of temporary closures during major flood events, consisting of staging and installing clay embankment plugs, or plastic sheeting and sand bag wall structures to repel the floodwaters. Nevertheless, as was the case in the 1993 flood, floodwaters rose rapidly, jeopardizing successful placement of these closures. The proposed closure improvements decrease the time to construct and would decrease the manpower.

The "No Action" alternative means that the Downtown East road and railroad closures would continue to be at risk during flood events. Demands for recreational facilities in the City have and would continue to increase. No substantial changes in environmental or cultural conditions should occur.

A major desire of the City is to maximize flood damage reduction at a reasonable cost. After review of the Feasibility Report, the Recommended Plan for flood damage reduction does reduce damages significantly with modification to 11 closures. Four permanent closures would be constructed, along with six narrowed closures and four gate closures within the amphitheater. Flood damage reduction measures must work cooperatively with the proposed Riverwalk facilities.

d) Reach 4: Downtown West Levee

The existing levee and floodwall system provides flood protection for slightly more than 100-year flood events. Flood fighting requires construction of temporary closures for flood events above the 10-year stage, consisting of installing clay embankment plugs or plastic sheeting and sand bag wall structures to repel floodwaters. In the 1993 flood event, floodwaters rose quickly, jeopardizing successful placement of these temporary closures. The proposed closure improvements decrease the time to construct and would decrease the manpower.

The "No Action" alternative means that the Downtown West road and railroad closures would continue to be at risk during flood events. Demands for recreational facilities in the City have and would continue to increase. Flood damage reduction measures must work cooperatively with the proposed River walk facilities.

The only alternative that would increase overall closure reliability with possible benefit/cost ratio greater than one is to permanently close four selected openings in the levee, narrow four more openings to decrease the size of the "temporary closure" structures, and build one gate closure required to increase overall closure reliability. Flood damage measures must work cooperatively with the proposed Des Moines Riverwalk facilities.

e) Reach 5: Downtown South Levee

The existing levee and floodwall system provides flood protection for events for slightly more than 100-year flood events. Flood fighting along Reach 5 requires construction of temporary closures during flood events in excess of the 100-year frequency. The closures consist of staging and installing clay embankment plugs or plastic sheeting and sand bag wall structures to repel the floodwaters. However, as was the case in the 1993 flood, floodwaters rose rapidly, jeopardizing successful placement of these closures. The proposed closure improvements decrease the time to construct and would decrease the manpower.

The "No Action" Alternative means that the Downtown South road and railroad closures would continue to be at risk during flood events. Demands for recreational facilities in the City have and would continue to increase. Flood damage measures must work cooperatively with the proposed Des Moines Riverwalk facilities

The only alternative with a possible benefit/cost ratio greater than one is to permanently close two selected openings in the levee to improve overall closure reliability.

f) Reaches 6 through 11

Reaches 6 through 11 have no federal interest because of B/C ratios below 1.0 and are therefore not included in this alternatives analysis.

6.C.2. Affected Environment

a) Reach 1: Birdland Park Levee

The Birdland Park area contains 170 acres of residential and commercial property. This area includes the North High School complex, Birdland City Park, and Riverview Park, in addition to numerous commercial establishments. The area is mapped in the National Flood Insurance Program as having 100-year flood protection by an existing levee constructed by the City in the 1950s. This levee was overtopped during the 1993 flood, causing extensive flood damage.

The levee was constructed of miscellaneous fill and has been found to contain rubble and debris. Today the top width and slopes are variable and do not meet minimum federal standards. In the years since construction, portions of the levee have become heavily overgrown with trees.

The structural diversity of the existing large trees, shrubs, and herbaceous plants growing on the levee provides habitat for a variety of animal and bird species. A bottomland hardwood forest of varying widths and distances to the Des Moines River borders the riverward side of the levee.

The Birdland Levee is part of and existing City' recreational trail system, the Neal Smith Trail, which runs beside and on the top of the levee, is a segment of the longer Saylorville Trail, all of which is highly used by recreationists.

In the spring of 2004, Phase IIA hazardous, toxic, and radioactive waste (HTRW) sampling revealed metals and polycyclic aromatic hydrocarbons (PAH) in low concentrations; however, these concentrations are in excess of the Iowa State Land Recycling Program Standards, however due to the very low concentrations the Iowa DNR has cleared the levee area and no remediation is required.

The Kiwanis Club leases Riverview Park from the City, and has developed a Master Plan for replacing the abandoned amusement park with a more natural setting for public recreation. The island has scattered large trees. A cattail marsh in the western end of the island and a scrub-shrub and emergent wetland along the northern and southern tips of the island increase the value of the area for wildlife and recreation. The large lagoons at the site are fed by groundwater and storm water and do not have a surface water connection to the Des Moines River.

b) Reach 2: Central Place Levee

The Central Place Business District is on the near north side of the City and now is home to numerous commercial properties. The area is protected from flooding by an earthen levee (with 222 feet of concrete floodwall underneath the University Avenue Bridge) constructed by the City in 1950. It is mapped in the National Flood Insurance Program as having 100-year flood protection. The levee was overtopped during the 1993 flood, causing extensive flood damages. Following the 1993 flood, the City undertook several measures to improve the level of protection provided by the levee; however, the levee still requires upgrading to meet the current USACE flood protection standards.

The Central Place area is unique since it is lower than the normal river levels and therefore, all runoff from the area must be pumped. The interior areas are presently serviced by four large stormwater pump stations, which were constructed by the City in the 1970s and upgraded in 1975. The City constructed a

new pump station at 2nd Avenue in 1997 that consists of three submersible pumps with a total capacity of 120,000 GPM.

The levee is overgrown with trees on both slopes extending out from the crown past the toe on both sides, which provides structural habitat diversity for various birds and small mammals. Animal holes and debris in the levee have contributed to the increased estimated probabilities of failure. The river side of the levee consists of bottomland hardwood forest scattered with open wetland herbaceous meadows dominated by the invasive species reed canarygrass *(Phalaris arundinacea)*. An upland forest borders the southern portion of the levee. The levee is currently used as an informal walking path and green space.

In the spring of 2004, Phase IIA hazardous, toxic, and radioactive waste (HTRW) sampling revealed metals and polycyclic aromatic hydrocarbons (PAH) in low concentrations; however, these concentrations are in excess of the Iowa State Land Recycling Program Standards, however due to the very low concentrations the Iowa DNR has cleared the levee area and no remediation is required.

Upland forest, emergent wetland, and open water creation would occur at the Chichaqua site, an 85-acre parcel currently owned by the City, as mitigation for most of the project impacts. This mitigation site is located within the larger Chichaqua Bottomlands Greenbelt, an approximately 7,000-acre area of marshes, forests, prairies, and oxbows being restored by a multi-agency effort led by the Polk County Conservation Board. The Chichaqua site itself was purchased by the City in order to utilize it for future mitigation projects as needed. One mitigation effort has already taken place in a 20-acre portion of the site, and that effort included the use of monitoring wells over the five-year monitoring period. Those monitoring well results would be analyzed during creation of plans and specifications to determine the appropriate depths of excavation needed to reach the water table. The Chichaqua mitigation site is currently used for row-crop agriculture, except for the area already developed into a wetland mitigation site. The "No Action" alternative would result in continued agricultural use of the site.

The bottomland forest mitigation for this project would occur within the existing wetland meadows riverward of the levee at Central Place. The meadows are currently dominated by the invasive species reed canarygrass (*Phalaris arundinacea*). This species is thought to have invaded the area after a large flood such as the flood of 1993, which killed many of the trees riverward of the levee. Dead tree trunks are scattered through some of the wet meadow areas. Mast-producing trees and fruiting shrubs would be planted within the wet meadows. The "No Action" alternative would likely result in most of the existing reed canarygrass area remaining a monoculture of that species, since most species cannot become established in the thick mass of dead reed canarygrass on the ground surface of these areas. Reed canarygrass monocultures are used by some birds for resting areas, although few birds nest in these areas, and very few species use them as a food source. Some of the upland forest mitigation would also occur riverward of the Central Place levee, in an existing mowed upland area in the northern end of Central Place. Mast-producing trees and fruiting shrubs would be planted within this area.

c) Reach 3: Downtown East Levee

The Southeast 6th to Southeast 14th Streets area along the north and east side of the Des Moines River, the core of Des Moines' central business district, is protected by a flood levee. This 0.5-mile stretch of the northern left floodplain was initially constructed by the City, and was incorporated into the federal levee system constructed in the late 1960s (the Des Moines Local Flood Protection Project Stage I). During the 1993 flood, this section of levee experienced severe erosion.

The levee system contains three major reaches of levee protecting both the right and left banks of the Des Moines and Raccoon Rivers and the area between the confluences of the two rivers. The protected areas contain over 1,800 acres of highly urbanized commercial, retail, industrial, residential, and public facilities at the central business core of the City.

This system, designed in the 1960s, has numerous street and sewer closures that penetrate the line-of-protection at the design flood level, requiring additional actions such as sandbagging, installing earthen closures, and placing and operating portable pumps. However, as demonstrated during the 1993 flood, floodwaters on both the Des Moines and Raccoon Rivers can rise rapidly, making the successful execution of these operations difficult.

A multi-use trail, John Pat Dorrian Trail, is a segment of the longer Saylorville Trail.

In the spring of 2004, Phase IIA hazardous, toxic, and radioactive waste (HTRW) sampling revealed metals and polycyclic aromatic hydrocarbons (PAH) in low concentrations; however, these concentrations are in excess of the Iowa State Land Recycling Program Standards, however due to the very low concentrations the Iowa DNR has cleared the levee area and no remediation is required

The Downtown East area is fully urbanized, dominated by buildings, pavement, mowed grass, and ornamental trees.

d) Reach 4: Downtown West Levee

This levee follows the westerly bank of the Des Moines River a thousand feet downstream of I-235 to the confluence of the Raccoon River then along the northern bank of the Raccoon River past Fleur Drive.

The floodwalls and levees built by the federal government in the 1960s and 1970s currently offer slightly more than 100-year flood event. Three pump stations remove stormwater from behind the levee during flooding. Ten closures need to be closed during flooding.

The levee is currently used as an informal walking path and green space.

In the spring of 2004, Phase IIA hazardous, toxic, and radioactive waste (HTRW) sampling revealed metals and polycyclic aromatic hydrocarbons (PAH) in low concentrations; however, these concentrations are in excess of the Iowa State Land Recycling Program Standards, however due to the very low concentrations the Iowa DNR has cleared the levee area and no remediation is required. The Downtown West area is urbanized, dominated by buildings, pavement, and mowed grass, with scattered ornamental trees. The levee in this area is well maintained and regularly mowed.

e) Reach 5: Downtown South Levee

Downtown South Reach is on the southerly bank of the Raccoon River, starting downstream of SW 7th Street and continuing along the Des Moines River to Hartford Avenue.

Reach 5 is protected by a federal levee against a 200-year flood event. The levee consists of grass covered earthen embankments, floodwalls and closures at 1st Street, Scott Avenue, SE 6th Street, and SE 14th Street. Three pump stations remove storm water during flooding.

Kruidenier Trail is a 2-mile multi-use recreational trail located at Gray's Lake Park; it is unique among the City's trails for the 1,500-foot bridge that allows the trail to encircle the lake. This trail is 2,000 feet from the levee.

The Phase I ESA found no recognized environmental conditions for this location.

The Downtown South area is highly urbanized and is dominated with buildings, pavement and mowed grass, with scattered ornamental trees. The levee in this area is well maintained and regularly mowed.

6.C.3. Environmental Impacts of the Preferred Alternative

a) Reach 1: Birdland Levee

The proposed levee reconstruction would impact emergent, scrub-shrub, and bottomland forest on the Kiwanis Riverview Park and the lagoon at the southern end of the levee reach by the placement of the

levee and would impact bottomland forest due to the need to clear and grub the area within 15 feet of the levee to prevent tree damage to the reconstructed levee. In addition, the existing levee is forested with upland tree species which would be removed during the levee reconstruction effort. The existing upland forests have structural diversity such as snags, canopy cover, understory, and downed logs, which is available habitat for a variety of species. The reconstructed levees would be kept mowed preventing regrowth of forest habitat on-site. Compensatory mitigation for project environmental impacts would occur as described in Section 1 of Appendix G.

Table 29: Birdland Park Alignment 2 Environmental Quality Account

[1]Acreage refers to emergent wetlands impacted through permanent filling from levee placement

Negative Impacts to:	No Action	100-year levee	250-year levee	500-year levee
Acres of Wetland Impact[1]	0	1.0	1.2	1.4 - 2.3
Acres of Bottomland Forest Impact[2]	0	0.2	0.2	0.2
Acres of Open Water Impact	0	2.4	2.5	2.7 - 3.8
Acres of Upland Forest Habitat Impact	0	1.4	1.4	1.4
Aesthetics	No	Yes	Yes	Yes
Cultural	No	No	No	No
Social-Economic	Yes	Yes	No	No

[2]Acreage refers to bottomland forest within 15 feet of the base of the proposed levee alignment

b) Reach 2: Central Place

The construction of the 500-year levee would involve the removal of the existing levee and replacement with a levee within the same footprint. The upland forest habitat on the existing levee would be impacted and the replacement levee would be kept mowed preventing regrowth of the forested community during the period of analysis. A bottomland forest community is present from the Des Moines River to the base of the existing levee. To prevent damage to the reconstructed levee, the bottomland forest would be removed within 15 feet of the levee toe during construction. That area would be maintained by mowing through the period of analysis. Compensatory mitigation would occur for project environmental impacts as described in Section 1 of Appendix G.

Table 30: Central Place Environmental Quality Account

Impacts Types	No Action	100-year levee	250-year levee	500-year levee
Acres of Wetland Impact	0	0	0	0
Acres of Bottomland Forest Impact	0	1.2	1.2	1.2
Acres of Open Water Impact	0	0	0	0
Acres of Upland Forest Habitat Impact	0	3.2	3.2	3.2
Endangered Species Habitat Impact (y/n-type)	No	No	No	No
Negative Aesthetics	No	Yes	Yes	Yes
Negative Cultural	No	No	No	No
Negative Social-Economic	Yes	Yes	No	No

c) Reach 3: Downtown East Levee

No adverse environmental impacts, as shown in Table 31, would occur from construction of these closure modifications, as they are located within an urbanized environment.

Table 31: Downtown East Closures Environmental Quality Account

Impact Types	No Action	Closure Modifications
Acres of Wetland Impact	0	0
Acres of Bottomland Forest Impact	0	0
Acres of Open Water Impact	0	0
Acres of Upland Forest Habitat Impact	0	0
Endangered Species Habitat Impact (y/n-type)	No	No
Negative Aesthetics	No	No
Negative Cultural	No	No
Negative Social-Economic	Yes	No

d) Reach 4: Downtown West Levee

No adverse environmental impacts, as shown in Table 33, would occur from construction of these closure modifications. All closure structures involved are located within an urbanized environment.

Table 32: Downtown West Closures Environmental Quality Account

Impact Types	No Action	Closure Modification
Acres of Wetland Impact	**0**	**0**
Acres of Bottomland Forest Impact	**0**	**0**
Acres of Open Water Impact	**0**	**0**
Acres of Upland Forest Habitat Impact	**0**	**0**
Endangered Species Habitat Impact (y/n-type)	**No**	**0**
Negative Aesthetics	**No**	**No**
Negative Cultural	**No**	**No**
Negative Social-Economic	**Yes**	**No**

6.C.4. Reach 5: Downtown South Levee

No adverse environmental impacts, as shown in Table 33, would occur from construction of these closure modifications. The closure-structures involved are located within an urbanized environment.

Table 33: Downtown South Closures Environmental Quality Account

Impact Types	No action	Closures
Acres of Wetland Impact	0	0
Acres of Bottomland Forest Impact	0	0
Acres of Open Water Impact	0	0
Acres of Upland Forest Habitat Impact	0	0
Endangered Species Habitat Impact (y/n-type)	No	0
Negative Aesthetics and Cultural	No	No
Negative Social-Economic	Yes	No

6.C.5. Cumulative Impacts

The permanent impacts expected as a result of this project are the emergent wetland, open water, bottomland and upland forest impacts at the Birdland and Central Place levees. In addition, wetlands would be excavated and upland forest habitat would be created at the Chichaqua mitigation site; and, upland and bottomland forest habitat would be created at the Central Place mitigation area (Table 34).

Table 34: Total Wetland Impacts and Mitigation

Habitat Types	Birdland Park Impacted Acres	Chichaqua [1] Mitigated Acres	Central Place Impacted Acres	Riverside of Levee [2] Mitigated Acres
Emergent Wetlands	1.4 to 2.3	2.8 to 4.6	0	0
Open water	2.7 to 3.8	2.7 to 3.8	0	0
Bottomland forest	0.2	0	1.2	2.6 [3]
Upland forest	1.4	6.4 [4]	3.2	2.2
Herbaceous buffer	0	1.2	0	0
Total Acres Impacted	10.1 to 12.1			
Total Acres of Mitigation	17.9 to 20.8			

[1] Chicaqua proposed wetland mitigation site, see Figure 8.
[2] Mitigtion site is riverside of the levee at Central Place, see Figure 13.
[3] 2.2. acres for Central Place & 0.4 acres for Birdland Park
[4] 2.6 Birdland Park & 3.8 Central Place

The levees to be reconstructed at Birdland and Central Place were originally built in the 1950s by the City. They currently do not meet federal standards and are not expected to be able to withstand a heavy flood. The downtown closure structures would create permanent closures where now temporary earthen closures are often used. The preferred alternative project at Birdland, Central Place, and Downtown would not create new levee reaches. Currently the existing levees do provide some protection for the City, although during large floods, such as the Flood of 1993, the levees fail. This project would strengthen and potentially raise the levees so that in future floods, the levees would be less likely to fail.

Much of the City is located within the floodplain of the Des Moines and Raccoon Rivers. There were likely many upland and bottomland forests and emergent wetlands in the area prior to European settlement. The existing bottomland forest adjacent to the Central Place levee is a remnant of the previously existing larger bottomland forest community. The forest would be mowed out to 15' riverward of the reconstructed levee in order to prevent damage to the levee. This would eliminate many large and small trees and shrubs. Mitigation would occur within that bottomland forest by planting mast trees in an area currently dominated by reed canarygrass. Reed canarygrass has minimal wildlife habitat value, so the mast trees are expected to adequately compensate for the loss of forested habitat.

Wetlands would be impacted at Birdland through creation of a new levee alignment at the northern end and a widening of the levee at the southern end. The wetlands to be impacted are adjacent to lagoons that are historic oxbows of the Des Moines River. These wetlands are also likely remnants of larger wetland complexes that had existed within the Des Moines area prior to European settlement. These wetland impacts would be mitigated through creation of wetlands at a mitigation site outside of the City. This would further reduce the overall wetland habitat remaining within the City.

The upland forests to be impacted by the levee construction at Birdland and Central Place have developed on the existing levees and were likely not originally found in that area, since it was likely too wet to support an upland forest community. The upland forest would be mitigated through planting of trees and shrubs at Central Place and the Chichaqua mitigation site.

The cumulative natural resource impacts associated with the downtown closure structures are expected to be minimal since they are located in already highly developed areas and would only make permanent portions of what is currently done on an as-needed basis during flood events.

The northern end of the Birdland levee is proposed to go through the center of the Kiwanis Riverview Park. This island was proposed by the Kiwanis to be a passive and active recreation area for the residents of Des Moines. Most of the open areas within the City have been developed for industrial, commercial, or residential buildings and roads, so there would be a cumulative loss of the contiguous parkland at the island by the construction of the levee through the middle of the island. Rather than one large open area, there would be a much smaller open area on the eastern end of the island and a small forested and emergent wetland area on the western end of the island. No new levee reaches are known to be proposed along the Des Moines River during the reasonably foreseeable future. In addition, since the current levee is only being modified and no new levee construction is proposed, except for a new section at the northern end of the Birdland reach, the construction of this project is not expected to cumulatively exceed any known biological or social thresholds.

There are no induced stage affects in the study area. See section 6.A.2 page 72 for discussion.

6.C.6. Endangered Species

Of the four species listed by the USFWS as potential threatened and endangered species located near the project area (bald eagle, Indiana bat, western prairie fringed orchid, and prairie bush clover), only the bald eagle and Indiana bat have suitable habitat within areas to be impacted by this project. However, as mentioned, informal consultation between the USFWS and the District determined that a biological assessment would not be required for these species under the proposed project. The presence of suitable Indiana bat habitat within the upland and wetland forests to be cleared would be evaluated prior to the completion of plans and specifications to allow for ongoing coordination with the US Fish and Wildlife Service. See Figure 23, *Endangered Species Clearance Flowchart* for a description of the process if endangered species are encountered.

6.C.7. Historic Properties

The District queried the most current version of the District Archeological Site and Survey Geographic Information Systems (GIS) databases (current as of April 2004) and determined that there is one previously recorded archeological site within the project area. Reaches 1, 2, and 5 have not been surveyed previously and there are no previously recorded sites within the levee construction, closure construction, and/or wetland mitigation areas. Portions of Reaches 3 and 4 have been surveyed and one archeological site, 13PK61, is located in Reach 4 and adjacent to a proposed railroad bridge closure structure.

Endangered Species Clearances Flowchart

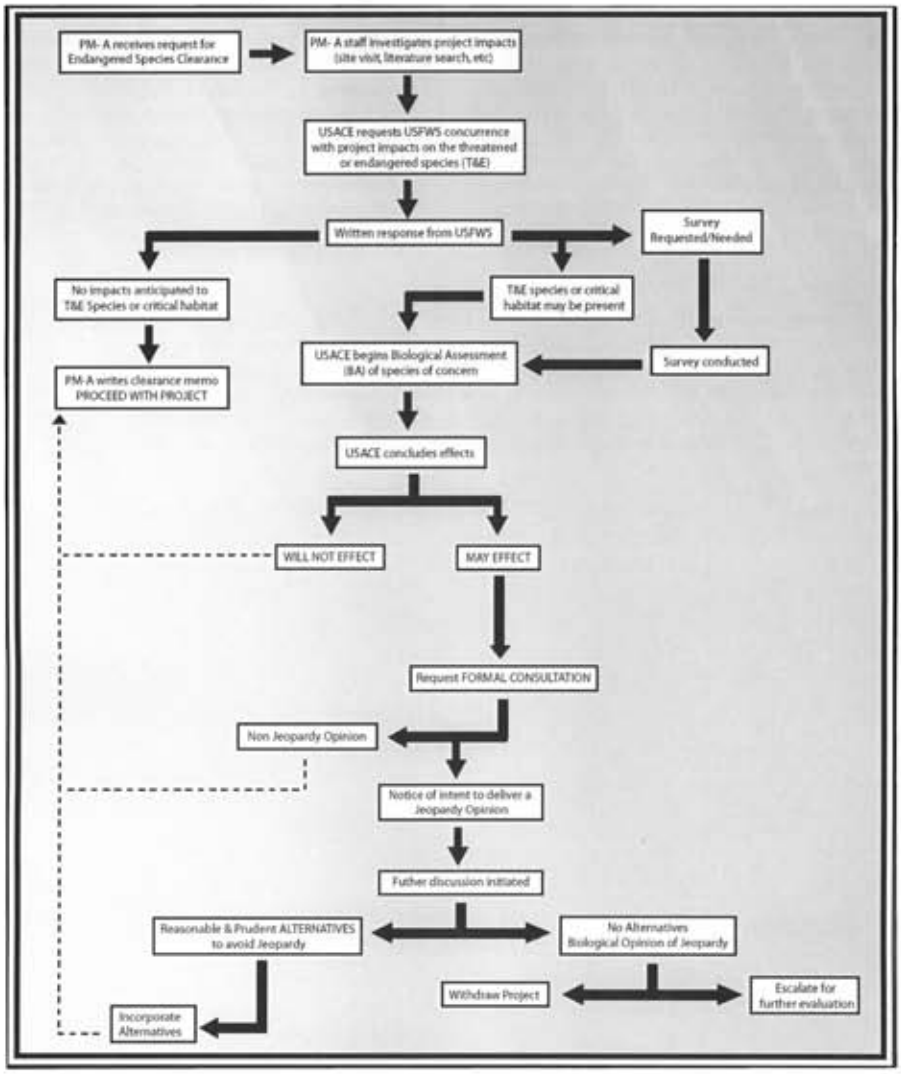

Figure 23: Endangered Species Clearance Flowchart

Of the 31 closure structures that are proposed, eight closures in Reach 3, seven closures in Reach 4, and one closure in Reach 5 are located within the Civic Center Historic District. Two closures are adjacent to the Court Avenue Bridge, a contributing resource to the NRHP Civic Center Historic District nomination and two closures are proposed for the Des Moines Union Railway Bridge, a structure that is individually eligible for inclusion on the NRHP. Finally, four closures in Reach 4 are located within the recorded boundaries of NRHP eligible archeological site 13PK61. Site 13PK61, Fort Des Moines No. 2, is a multi-component prehistoric and historic archeological site. Numerous investigations have evaluated portions of the site and it was formally determined eligible for inclusion on the National Register of Historic Places (NRHP) in 2000.

The District determined that the proposed closures would have "No Effect" on historic properties because of the minimal impact of the work. Ground disturbance associated with all closure construction would be limited to previously disturbed ground associated with the existing facilities including levees, flood walls, roads, and bridges. In addition, the minimal impact of the closures would not alter the defining characteristics of the known historic properties including the Civic Center Historic District, its contributing resources, or the individually significant Des Moines Union Railway Bridge. Work associated with the closures within the boundaries of site 13PK61 is limited to ground disturbed by bridge and levee construction and consequently will have No Effect on the site.

The District determined that ground disturbance associated with work proposed at Reaches 1 and 2, and with wetland mitigation would require archeological evaluation and deep geomorphological assessment in order to assess the effects to archeological cultural resources. The District contracted with Great Lakes Archaeological Research Center (GLARC) under contract W912EK-04-D-0001 to conduct the work. The investigation documented one archeological isolated find of unknown prehistoric affiliation and recommended that the cultural resource be determined ineligible for inclusion to the NRHP. The GLARC investigation recommended cultural resource management clearance for Reaches 1, 2, and the wetland mitigation areas. The District concurred with that recommendation and provided the report with a determination of "No Historic Properties Effected" to the SHSI by letter dated May 26, 2004. The SHSI concurred with the District determination by letter dated June 17, 2004 (R&C#: 000377008).

An additional consultation letter dated July 21, 2004 was mailed to the SHSI, relevant federally-recognized tribes, and the interested public that fully addressed the undertaking's potential effects on historic properties and particularly tribal concerns about properties that may be of religious and cultural significance (36CFR800.4 (a)(3-4)). The District determined that the preferred alternative would have No Effect on historic properties. The SHSI concurred with the District determination by letter dated August 9, 2004 (R&C#: 000377008). The SHSI concurred with the "No Effect" determination as it pertained to Reach 1, Reach 2, and those project features located outside of known historic district and individual historic property boundaries. The SHSI recommended a "No Adverse Effect" determination for those project features within known historic property boundaries in Reaches 3, 4, and 5. The Otoe-Missouria Tribe notified the District by letter dated August 26, 2004 that they had no knowledge of properties within the project "Area of Potential Effect" but that they would like to be notified in the event of inadvertent discoveries during project construction. No additional historic properties or concerns were identified as a result of the consultation. It is the opinion of the District that this undertaking is in full compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations 36 CFR Part 800: "Protection of Historic Properties."

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 District will discontinue project activities and resume coordination with the consulting parties to identify the significance of the historic property and determine any potential effects.

6.C.8. Environmental Impacts of Nonpreferred Alternatives

a) Reach 1: Birdland Levee

In the "No Action" alternative, the environmental resources would remain intact for the foreseeable future. The 100- and 250-year flood heights for Alignment 2 would involve less wetland and open water impacts since the levee footprints would be smaller. These non-preferred alternatives involve the same levee alignment, so no additional wetland or open water areas would be impacted by these alternatives. Alignment 1 would have minimal environmental impacts since most of the levee and floodwall would be located in an existing developed upland. Alignment 3 would have substantially greater environmental impacts since it is located in an area with bottomland forest, emergent wetlands, and open water surrounding much of the levee length.

b) Reach 2: Central Place Levee

The "No Action" alternative would not involve any environmental impacts. The upland and bottomland forests would continue to grow, with the trees becoming taller and the structure becoming more diverse. The existing reed canarygrass areas within the bottomland forest would likely remain for the foreseeable future since it is very difficult for trees or shrubs to seed themselves into areas fully vegetated with reed canarygrass. The mitigation effort associated with the preferred alternative would involve the planting of hard mast tree species within the reed canarygrass areas to eventually shade it out and provide additional wildlife habitat value, so that would not be done under the "No action" alternative. The 100-year and 250-year levee alternatives would have the same impacts as the preferred alternative since the levee footprint would remain the same for those alternatives.

c) Reach 3: Downtown East Levee

No foreseeable adverse environmental impacts would result from the "No Action" alternative. No other non-preferred alternatives were considered for this reach.

d) Reach 4: Downtown West Levee

No foreseeable adverse environmental impacts would result from the "No Action" alternative. No other non-preferred alternatives were considered for this reach.

e) Reach 5: Downtown South Levee

No foreseeable adverse environmental impacts would result from the "No Action" alternative. No other non-preferred alternatives were considered for this reach.

6.C.9. Probable Adverse Environmental Impacts which Cannot Be Avoided

The Birdland Levee would impact approximately 1.4-2.3 acres of emergent wetlands located within the footprint of the new levee and adjacent seepage berm and depression fill. The new levee section in the northern portion of the Birdland reach would also impact approximately 2.7-3.8 acres of open water in the lagoons surrounding the Kiwanis Riverview Park. In addition, approximately 0.2 acres of bottomland forest and 1.4 acres of upland forest habitat would be lost during construction of the Birdland levee.

Approximately 1.2 acres of bottomland forest adjacent to the reconstructed Central Place levee and approximately 3.2 acres of upland forest habitat that currently exists along the un-maintained levee slopes would be lost during construction.

The mitigation plan for the upland forest, bottomland forest, emergent wetland, and open water impacts associated with the Birdland and Central Place levees is described in Section 1 of Appendix G.

The Downtown closure structures are not expected to result in any wetland, open water, or forest impacts since they are primarily located in heavily developed areas.

6.C.10. Compliance with Environmental Quality Statutes

Table 35: Environmental Law Compliance and Applicability Required for Recommended Plan

Federal Environmental Protection Statutes and Requirements	Applicability/Compliance
Archaeological and Historic Preservation Act, 16 U.S.C. 469, et seq.	Full compliance
Clean Air Act, as amended, 42 U.S.C. 1857h-7, et seq.	Full compliance
Clean Water Act, Sections 404 and 401	Full compliance
Coastal Zone Management Act of 1972, as amended	Not applicable
Endangered Species Act of 1973, as amended, 16 U.S.C. 1531, et seq.	Full compliance
Environmental Effects Abroad of Major Federal Actions (E.O. 12114)	Not applicable
Estuary Protection Act, 16 U.S.C. 1221, et seq.	Not applicable
Farmland Protection Policy Act. 7 U.S.C. 4201, et seq.	Full compliance
Federal Water Project Recreation Act, 16 U.S.C. 460-1(12), et seq.	Full compliance
Fish and Wildlife Coordination Act, 16 U.S.C. 661, et seq.	Full compliance
Flood Plain Management (E. O. 11988)	Full compliance
Land and Water Conservation Fund Act, 16 U.S.C. 460/-460/-11, et seq.	Not applicable
Marine Protection Research and Sanctuary Act, 33 U.S.C. 1401, et seq.	Not applicable
National Economic Development (NED) Plan	Full compliance
National Environmental Policy Act, 42 U.S.C. 4321, et seq.	Full compliance
National Historic Preservation Act, 16 U.S.C. 470a, et seq.	Full compliance
Protection of Wetlands (E. O. 11990)	Full compliance
Rivers and Harbors Act, 33 U.S.C. 403, et seq.	Full compliance
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	Not applicable
Wild and Scenic Rivers Act, 16 U.S.C. 1271, et seq.	Full compliance

Full compliance - Having met all requirements of the statute for the current stage of planning (either preauthorization or post authorization).
Not applicable - No requirements for the statute required; compliance for the current stage of planning.

a) Archaeological and Historic Preservation Act

The project is in compliance with this act.

b) Clean Air Act, as amended

No aspect of the proposed project, neither short-term nor long-term, has been identified that would result in violations to air quality standards. The environment would not be exposed to contaminants/pollutants in such quantities and of such duration as may be or tend to be injurious to human, plant, or animal life, or property, or which unreasonably interferes with the comfortable enjoyment of life, or property, or the conduct of business.

c) Clean Water Act (Sections 401 and 404), as amended.

A Section 404(b)(1) Evaluation was prepared and is attached to this report as Appendix I. Certification under Section 401 of this Act from the State of Iowa would be obtained before project construction. Due to the unavoidable impacts to approximately 1.4 to 2.3 acres of emergent wetlands at the Birdland and Central Place reaches and 2.7-3.8 acres of open water impacts at the Birdland reach, compensatory mitigation would be provided. See Section 1 of Appendix G for the compensatory mitigation plan.

d) Endangered Species Act of 1973, as amended.

The proposed project has the potential to impact two species listed or proposed for listing under the Federal Endangered Species Act, the bald eagle and the Indiana bat. Informal consultation between the USFWS and the District determined that a biological assessment would not be required for these species under the proposed project. Project plans have been and will continue to be coordinated with the USFWS and the Iowa DNR. No State-listed threatened or endangered species are known to be present in the project area. The District's coordination letter and resource agency responses appear in Appendix H.

e) Farmland Protection Policy Act of 1981,

The Chichaqua mitigation site is currently being farmed. This will cease when mitigation construction is initiated, and is not expected to resume, since the site is proposed to be managed as a natural area in perpetuity. The NRCS Soil Scientist in Polk County indicated that a Farmland Conversion Impact Rating analysis is not necessary for this project since most of the mitigation is being performed on hydric soils and creation of wetlands on hydric soils is consistent with the direction of various NRCS programs for agricultural settings. In addition, the mitigation effort will not permanent alter the landscape in such a way that farming would not be possible again at the site in the future. The phone log documenting the conversation between the District biologist and the NRCS Soil Scientist is located in Appendix H.

f) Federal Water Project Recreational Act,

This Act requires that recreation opportunities be considered during the investigation and planning of any Federal navigation or other water resource project. The City is interested in creating an Americans with Disabilities Act (ADA) compliant bike trail on the proposed reconstructed Birdland levee. This would provide additional recreation opportunities for local residents and visitors to Des Moines.

g) Fish and Wildlife Coordination Act,

Project plans have been coordinated with the USFWS and the Iowa DNR. The District's coordination letter and resource agency responses appear in Appendix H.

h) Flood Plain Management, (Executive Order 11988).

This executive order requires federal agencies to evaluate and consider alternatives to avoid adverse effects and incompatible development in the floodplain. This project involves the protection of developments already existing within the floodplain and this project alone is not expected to increase incompatible development within the floodplain.

i) National Environmental Policy Act, of 1969, as amended.

The compilation of this integrated EA and the signing of the Finding of No Significant Impact fulfill NEPA compliance.

j) National Historic Preservation Act of 1966, as amended (NHPA).

The District consulted with the SHSI, relevant federally-recognized tribes, and the interested public regarding this undertaking's potential effects on historic properties and particularly tribal concerns about properties that may be of religious and cultural significance (36CFR800.4(a)(3-4)). The SHSI concurred with the District's determination of "No Effect" by letter dated July 21, 2004 (R&C#: 000377008). No

additional historic properties or concerns were identified as a result of that consultation. It is the opinion of the District that this undertaking is in full compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations 36 CFR Part 800: "Protection of Historic Properties."

k) Protection of Wetlands, (Executive Order 11990)

This executive order states that each federal agency shall avoid undertaking new construction located in wetlands unless there is no practicable alternative to such construction, and the proposed action includes all practicable measures to minimize harm to wetlands. As previously discussed, approximately 1.4 to 2.3 acres of emergent wetlands, 2.7-3.8 acres of open water, and 1.4 acres of bottomland forest would be impacted as a result of this project. These wetland and water impacts have been minimized to the extent possible. The wetland impacts at the Birdland reach were evaluated for each of the three alignments, and Alignment 2 was selected in part due to its lesser degree of wetland impacts than would occur at Alignment 3. Alignment 1 was not considered to be practicable due to a closer benefit/cost ratio. The Central Place reach wetland impacts are due to leveling and maintenance of the existing bottomland forest area up to 15 feet riverward of the levee. That area will remain as a wetland, but will be mowed, so the functions and values of the wetland will be greatly reduced. Each of the wetland impacts will be mitigated to replace lost wetland functions and values.

l) Rivers and Harbors Act

The proposed plan would not place any permanent obstruction across navigable water nor would it place obstructions to navigation outside established federal lines.

m) Wild and Scenic Rivers Act of 1968, as amended

The Des Moines and Raccoon Rivers are not listed in the National Rivers Inventory (NRI). The NRI is used to identify rivers that may be designated by Congress to be Component Rivers in the National Wild and Scenic Rivers System.

6.C.11. Relationship between Short-Term Use and Long-Term Productivity

When the levees at Birdland and Central Place and the closure structures in the downtown reaches are constructed, they will be utilized during each high water event over the period of analysis. This includes flooding events in both the short-term and the long term. The long-term productivity of the project is expected to outweigh any short-term resource uses such as borrow site excavation, use of fuel during construction, and labor.

6.C.12. Any Irreversible or Irretrievable Commitments of Resources if Project is Implemented

Approximately 17,300 cubic yards of borrow material would be used to construct the Birdland levee and approximately 132,740 cubic yards of borrow would be used to construct the Central Place levee. The Downtown closure structures would require a minimal amount of borrow material since those are mainly small earthen embankments or floodwalls. Much of the required borrow material has been gathered by the City from various construction projects and stockpiled for use by this project. That soil can be reasonably thought to be irretrievable once the levees are constructed. The cost of this project also represents an irretrievable commitment of funds once the project is constructed. The compensatory mitigation sites are proposed to be preserved in perpetuity. This would result in an irreversible commitment of the land to be used for mitigation. The fuel consumed, manpower expended, and the commitment of construction materials and equipment is considered irretrievable.

6.C.13. Socioeconomic Impacts of the Preferred Alternative

a) Community and Regional Growth

No significant impacts to the growth of the community or region would be realized because of the proposed levee and closure improvements.

b) Community Cohesion

The proposed project would be expected to somewhat enhance community cohesion by further reducing the threat of flooding and securing the economic viability of businesses located in the floodplain. The project would involve rebuilding the existing levee to meet current USACE design standards and rebuilding selected road and bridge closures to improve the reliability of positive closure during a flood event. Minimal resultant impacts to residential, industrial, or commercial developments within the vicinity are expected.

Views expressed at a public meeting held at the onset of the study phase allowed the public to view the proposed projects and to provide feedback. Overall, the majority of comments provided were in favor of the proposal, indicating public support and anticipation of project completion. No responses expressed any disagreement with the proposed project.

c) Displacement of People

No residential displacements would result from the proposed action.

d) Property Values and Tax Revenues

Property values and resulting tax revenues may increase because of the increased flood protection provided by the proposed project.

e) Public Facilities and Services

Public facilities located within the floodplain would benefit from a reduced threat of damages following project construction of improving the levee.

Birdland Park area provides recreational opportunities such as walking, biking, picnicking, and fishing. The integrity of the existing levee in this area is compromised by the trees growing through the levee. The trees would be removed when the levee is degraded and reconstructed. An alternate bike path would be provided for the recreationists during the time of the construction of the levee. In addition, a public handicap access ramp would be built to provide accessibility to the trail and neighborhood, which is not currently available.

The local Kiwanis Club currently maintains the Birdland Park area. The proposed levee alignment would essentially divide this recreation area in half and would restrict further development of the site by the Kiwanis.

Vehicle traffic in the downtown project area would be reduced to one lane during construction. There is potential for temporary closures at Birdland Avenue and Saylorville Road during the construction phase. Access to public roads throughout the project areas would be maintained to avoid disruptions to traffic flow and to minimize inconvenience for residents and emergency vehicles.

f) Life, Health, and Safety

Upgrading the City's existing flood protection in the proposed project areas would further reduce the potential for flooding in the areas and hence would further reduce life, health, and safety threats faced by area residents.

During the construction phase, disruption of traffic would occur in the project areas. Borrow material would need to be transported to the Birdland project site, and would increase traffic in the area by

approximately 90 truck trips per day. The trucks would travel approximately five miles along existing major traffic arteries to haul material to the placement site. Increased traffic would cause the most concern during the early morning hours when staff and students are traveling to school and residents are driving to work, and again in early evening when residents are returning home from work. During the construction phase of the Downtown area project, traffic would be reduced to one lane for approximately one to two months.

The City intends to monitor all of these locations during project construction and would provide flagmen to direct traffic and minimize safety concerns, if needed.

A hazardous, toxic, and radioactive waste (HTRW) compliance assessment was conducted. The findings of the assessment revealed recognized environmental conditions within the proposed project areas except the Downtown South area. The conditions were confirmed, revealing metals and PAH concentrations in excess of the Iowa State Land Recycling Program Standards. Before construction can proceed, all lands must receive a No Further Remedial Action Planned Certificate.

g) Business and Industrial Growth

The proposed project would positively impact community business and industrial activity by reducing the threat of flooding. Business activity would temporarily increase during construction of the levee; no long-term impacts would result. No business relocations would be required for the proposed project.

h) Employment and Labor Force

The project would not directly affect the permanent employment or labor force in Des Moines, Iowa. However, the project would temporarily increase area employment during the construction phase.

i) Farm Displacement

The proposed project is located within an urban area; therefore, no farms would be displaced.

j) Noise Levels

Overall, heavy machinery would generate an increase in noise levels throughout the project areas during construction and temporarily disturb residents and recreationists.

The proposed project at Birdland is located near an existing light industrial area that already has a high noise level. A residential area is located on a bluff overlooking the construction site; however, it is unlikely that the construction would significantly affect the residences.

Once the project is completed, noise levels would return to existing conditions and no significant long-term noise impacts are anticipated.

k) Aesthetics

A main concern of many residents is the removal of the trees on the existing levee in the Birdland Park area and the resulting negative impacts on the aesthetics of the bike path throughout this area. Since the trees are growing through the existing levee and are compromising the integrity of the levee, it is necessary to remove the trees to provide a sound flood control system.

6.C.14. Relationship to Land Use Plans

The lands protected by the Birdland, Central Place, and Downtown levees are urban areas and heavily developed. The lands include commercial, industrial, and residential areas. This project proposes to replace existing levees at Birdland and Central Place and add permanent closure structures to the Downtown levee reaches. No new levees are proposed to be constructed, except for the northern portion of the Birdland levee. Therefore, the existing land use of the lands at the levee locations and the lands protected by the levees are not expected to change because of this project, and this project is compatible

with all existing land use plans. The Chichaqua compensatory mitigation site is owned by the City for use as a mitigation site, so the creation of wetlands and an upland forest area would be compatible with the existing land use plans of the site. It is also located within the larger Chichaqua Bottoms Greenbelt area, managed by the Polk County Conservation Board, which is a large restoration area located along the Skunk River with the intent to restore over 7,000 acres of bottomland area for natural resource and recreational purposes. The Central Place mitigation area involves the planting of trees in upland and wetland areas to compensate for upland and wetland forest losses associated with the project impacts. The mitigation area is located between the existing levee and the Des Moines River, so it currently functions as a natural area, and that would not change after the trees are planted in that area.

6. D. PRODUCT DELIVERY TEAM

Table 36: Team Members/Qualifications

Name/Position	Brief Biography
Dennis Hamilton Project Manager	Dennis Hamilton is a senior project manager in the Rock Island District with responsibility for flood damage reduction and recreation projects. Mr. Hamilton has been with the Rock Island District for 7 years and has over 20 years of experience in design, construction, and management of water resource projects. He has a BS in Civil Engineering from Iowa State University and is a registered Professional Engineer in Iowa and Colorado.
Roger Less Project Engineer	Roger Less has been a Supervisory Civil Engineer in the Project Engineering Section of Design Branch for the Rock Island District, USACE for the past 4 years. Prior to this position, Mr. Less was a Project Engineer for 10 years and a Hydraulic Engineer for 6 years with the District and served as a Water Resources Engineer for the State of Iowa for 6 years. He has a BS in Civil Engineering from Iowa State University in 1978 and has been a Professional Engineer since 1983.
Dean Cerny Project Engineer	Dean Cerny is a project engineer for Rock Island District. He graduated from the United States Military Academy in 1981 with a Bachelor of Science Degree in Engineering. He was assigned to a construction battalion and the US Army Engineer School prior to arriving at the Rock Island District in 1989. He has a master's degree in Construction Management from George Washington University and is a registered professional engineer in the State of Illinois.
George Staley Hydrologist	George Staley is a hydraulic engineer at Rock Island District. He has an MS in Civil Engineering (water resources) and a BS in Mechanical Engineering. Most of his experience is with the government, although he worked in private industry for about ten years after graduating from college.
Rowland Fraser Hydrology	Mr. Rowland Fraser currently is a Hydrologic Technician for the Corps of Engineers. He has been with the Rock Island District for 25 years, working in the Survey section for a year before moving to the Hydraulics and Hydrology section where he has excelled since 1980.
Don Bawmann Geotechnical	Donald H. Bawmann is presently serving as a Senior Geotechnical Engineer Specialist for the Rock Island District. He has 47 years of geotechnical service, 43 with the government and 4 with the private sector. He received his education in the Civil Engineering curriculum from the University of Illinois, University of Iowa, University of Wisconsin, Michigan State University, Augustana College, Blackhawk College, and Virginia Polytechnic Institute and State University.

Name/Position	Brief Biography
Sibte Zaidi Geotechnical	Sibte Zaidi has been working as a geotechnical engineer since 1981 for Rock Island District Geotechnical Branch. He was graduated in May 1977 with BS in Civil Engineering from University of Puerto Rico, Mayaguez. Prior to this assignment, he worked with Puerto Rico Aqueduct and Sewer Authority as a civil engineer.
Terri Kirkeeng Cost Engineering	Ms. Terri Kirkeeng is currently a Civil Engineer for the Corps of Engineers and is leading the Cost Estimating section. She received a Bachelors in Civil Engineering from Iowa State University, and has been with the Corps for 21 years. During that time she has worked in both Programs Branch and Engineering Branch. She had been a Cost Engineer for the eight years before taking lead of the section.
Terry Riddell Real Estate	Terry Riddell has been a Realty Specialist with the Corps for over 11 years, with 15 years with the Federal Government. He started with a year of real estate classes at El Camino College in Torrance, California. He then received a real estate sales license and a broker's license (1980) through private schools for the State of California. He moved from California to Arizona in 1986 and attended another private school in Arizona to receive a broker's license for the State of Arizona in 1987. All of the licenses were acquired after a four hour examination process in each state.
Dan Fetes Economist	Dan Fetes has been employed by the Rock Island District as a Regional Economist for more than 20 years. He was previously employed as a Bank Examiner for the FDIC. Mr. Fetes received his bachelor's degree in Finance from the University of Wisconsin, Eau Claire, and an MBA from the University of Iowa.
Gail Clingerman Biologist	Gail Clingerman has been a biologist in the Economic and Environmental Analysis Branch of the Planning, Programs, and Project Management Division for three years. Prior to that, she worked as a wetland consultant for an engineering consulting firm in Iowa City. She came to that position after working as a biologist in the Regulatory Division of the New England District. Gail began working for the Corps of Engineers, Rock Island District, as a co-op student in 1993. She received her bachelor's degree in biology from Augustana College, Rock Island, Illinois and became a certified Professional Wetland Scientist in 2001.
Jim Ross Archeologist	James Ross has been an archeologist for the Rock Island District for the last ten years having graduated from North Texas State University with a BA in Anthropology in 1985 and from Southern Illinois University-Carbondale with an MA in Anthropology in 1991. Mr. Ross served as a project manager for a private archeological consulting firm for four years prior to his employment with the Rock Island District.
Sue Simmons Public Involvement	Suzanne R. Simmons has been employed by U.S. Army Corps of Engineers, Rock Island District, for 29 years, serving as Public Involvement Specialist since 1988.
Tracy Street Social Impacts	Tracy M. Street has been employed by U.S. Army Corps of Engineers, Rock Island District, for five years, serving as a student aide and co-op student. Ms. Street graduated Black Hawk College with and Associates in Arts and currently is working on a Bachelors degree at Western Illinois University, Quad City Campus. Ms. Street is working closely with Sharryn Jackson on learning to write Social Impacts for projects.

Name/Position	Brief Biography
Kara Mitvalsky Environmental Engineer	Kara Mitvalsky has been an environmental engineer for Rock Island District since 1998. Prior to working for the Corps, Ms. Mitvalsky was a radiation specialist for the U.S. Nuclear Regulatory Commission. Ms. Mitvalsky is a registered professional engineer in the State of Iowa. Ms. Mitvalsky received her M.S. from the University of Iowa, and her B.S. from Northwestern University, both degrees in the field of Environmental Engineering.
Amy Moore Hazardous, Toxic and Radioactive Waste Specialist	Amy Moore has been a civil engineer for the Rock Island District since 2001. Ms. Moore is a registered Engineer Intern in the state of Michigan. Ms. Moore received her M.S. and B.S. from Michigan Technological University, both degrees in civil engineering.
Steve Russell Study Manager	Steve Russell has been a planner/study manager for Rock Island District for the last three-and-a half years having graduated from Kansas State University with a BS in Mechanical Engineering in 1985. Prior to this assignment; he worked for several DoD agencies as a program manager in environmental and other engineering disciplines.

7. PLAN IMPLEMENTATION

This section summarizes cost-sharing requirements and procedures necessary to implement the flood damage reduction measures of the selected/recommended plan. Table 37 table summarizes the schedule of activities needed to implement the projection dates.

Table 37: Summary of Action Items and Schedule to Complete Project

Action Item	Estimated Completion Date
Washington Level Policy Review	Oct-05
Chief of Engineers Report	Dec-05
Administration Review	Apr-06
Congressional Authorization	Sep-06
Submit draft Project Cooperation Agreements (PCA) for review	Jul-07
Federal Construction Fund Appropriation	Oct-07
PCA Review and Approval	Dec-07
Execute PCA	Jan-08
Complete Plans & Specifications	Jun-08
Real Estate Acquisition	Aug-08
Construction Contract Advertisement & Bidding	Sep-08
Construction Contract Award	Nov-08
Complete Construction	Nov-10
Project Closeout	Sep-11

7. A. INSTITUTIONAL REQUIREMENTS

The following are procedures necessary for authorization and construction of the recommended plan:

(1) USACE, Mississippi Valley Division Commander will review the final report, and then issue a public notice announcing completion of the final Feasibility Report. This is referred to as the Division Engineer's Notice, or DE's Notice.

(2) This report will be submitted for review by the Headquarters of USACE, Washington D.C.

(3) The Chief of Engineers will seek formal review and comment by the City and interested federal agencies.

(4) Following City and other agency review, the report will be sent to the Assistant Secretary of the Army for Civil Works.

(5) Upon approval of the Assistant Secretary, the report will be forwarded to the Office of Management and Budget to obtain the relationship of the project to programs of the President.

(6) The Assistant Secretary of the Army for Civil Works will then forward the final report of the Chief of Engineers to Congress.

(7) Congressional review of the feasibility report and possible authorization of the project would follow.

(8) Pending project authorization for construction, the Chief of Engineers could include funds where appropriate, in his budget requests for preconstruction engineering and design of the project.

(9) Following receipt of funds, preconstruction engineering and design would be initiated and surveys and detailed engineering designs would be accomplished.

(10) Following Congressional authorization of the project, the District Engineer would accomplish plans and specifications.

(11) Subsequent to appropriation of construction funds by Congress, but prior to construction, formal assurances of local cooperation would be required from non-federal interests.

(12) Bids for construction would be initiated and contracts awarded.

(13) Upon completion of construction, the project will be turned over to the City, who will be responsible for OMRR&R (operating, maintaining, replacing, repairing, and rehabilitating) in accordance with guidelines provided by the USACE.

7. B. DIVISION OF PLAN RESPONSIBILITIES COST ALLOCATION

7.B.1. Federal Responsibilities

Cost sharing for construction of this project would be in keeping with current USACE policy for flood control projects. The Federal Government will be responsible for preparation of the Feasibility Study, PCA (Project Cooperation Agreement), Design Documentation Report, and Plans and Specifications for this project.

A State Flood Plain permit will be required. A Section 402, National Pollution Discharge (NPDES) permit, is required because more than 5 acres of land will be disturbed.

Additionally, Clean Water Act Section 404 and 401 permits would be required for construction at Reach 1, Birdland Park and Reach 2, Central Place, due to approximately 2.8 to 3.7 acres of wetland impacts and 2.7 to 3.8 acres of open water impacts.

7.B.2. Non-Federal Responsibilities

It is recommended that the flood damage reduction improvements defined in this report be authorized subject to the Sponsor agreeing to comply with applicable federal laws and policies, including the following requirements:

(1) Provide a minimum of 35 percent, but not to exceed 50 percent, of total project costs allocable to structural flood control and 50 percent of total project costs allocable to recreation, as further specified below:

(a) Enter into an agreement which provides, prior to construction, 25 percent of design costs;

(b) Provide, during construction, any additional funds needed to cover the non-federal share of design costs;

(c) Provide, during construction, a cash contribution equal to 5 percent of total project costs attributable to structural flood control;

(d) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

(e) Provide or pay to the Government the cost of providing all retaining dikes, waste weirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

(f) Provide, during construction, any additional cash contribution as necessary to make its total contribution equal to 35 percent of total project costs allocable to structural flood control and 50 percent of total project costs allocable to recreation.

(2) For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Government, in accordance with applicable federal and state laws and any specific directions prescribed by the Government.

(3) Grant the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local Sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

(4) Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating the project or completed functional portions of the project, including mitigation features without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with applicable federal and state laws and specific directions prescribed by the Government in the Operation and Maintenance manual and any subsequent amendments thereto.

(5) Support the Government's obligation to comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project, or separable element thereof, until the Sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

(6) Hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

(7) Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

(8) Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the Sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

(9) Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

(10) As between the Federal Government and the Sponsor, the Sponsor shall be considered the operator of the project for the purpose of CERCLA liability. To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

(11) Prevent future encroachments on project lands, easements, and rights-of-way which might interfere with the proper functioning of the project.

(12) Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR, Part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

(13) Comply with all applicable federal and state laws and regulations, including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), requiring non-federal preparation and implementation of floodplain management plans.

(14) Provide the non-federal share of total cultural resource preservation mitigation and data recovery costs attributable to structural flood control and to recreation that are in excess of 1 percent of the total amount authorized to be appropriated for structural flood control and recreation.

(15) Participate in and comply with applicable federal floodplain management and flood insurance programs.

(16) Do not use federal funds to meet the Sponsor's share of total project costs unless the federal granting agency verifies in writing that the expenditure of such funds is expressly authorized by statute.

(17) Inform affected interests, at least annually, regarding the limitations of the projection afforded by the project.

(18) Prescribe and enforce regulations to prevent obstruction of or encroachment on the Project that would reduce the level of protection it affords or that would hinder operation or maintenance of the Project.

(19) Provide and maintain necessary access roads, parking areas and other public use facilities, open and available to all on equal terms.

7.B.3. Non-Federal Sponsor Financial Analysis

Financial information on the non-federal Sponsor's ability to fund its share of the plan is required to proceed with the project as required by USACE Principles and Guidelines. The information includes a preliminary financing plan outlining the costs, schedule of expenditures, and a statement of financial capability by the Sponsor. The City has expressed their financial capability in their Letters of Intent. A Statement of Financial Capability and Financing Plan can be found in Appendix B on pages B-25 and B-29-31. The City intends to provide its financial requirements through its normal annual budget appropriations process (Capital Improvements Budget). The following table shows the estimated distribution of the project costs.

Table 38: Project Cost Distribution, Des Moines Iowa (Oct 2005 Price Level)

Project Alternative	Birdland Park 500-Year	Central Place 500-Year	Downtown East 500-Year	Downtown West 500-Year	Downtown South 500-Year	Flood Damage Reduction Totals	Birdland Recreation Trail	Totals
Total Project Cost Estimate	5,221,000	4,032,000	678,000	274,000	32,000	10,237,000	254,000	10,491,000
Federal Cost Share	3,394,000	2,621,000	441,000	178,000	21,000	6,655,000	127,000	6,782,000
Non-Federal Cost Share	1,827,000	1,411,000	237,000	96,000	11,000	3,582,000	127,000	3,709,000
Lands, Damages, Relocations	773,000	164,000	9,000	9,000	8,000	963,000	0	963,000
Cash Contribution	1,054,000	1,247,000	228,000	87,000	3,000	2,619,000	127,000	2,746,000
Non-Federal Cost-Share Percentage	35.00%	35.00%	35.00%	35.00%	35.00%	35.00%	50.00%	

7.B.4. Ability to Pay

Based on the provisions of Section 103 of Public Law 99-662, Des Moines, Iowa has the ability to provide the normal share percentage of project costs. This Public Law considers the magnitude of a project benefit-to-cost ratio and the per capita income of the state and county of the Sponsor. Des Moines does not qualify for reduced cost-sharing. Table B-19 in Appendix B, *Economic Analysis*, summarizes the required information.

7.B.5. Real Estate Requirements

The project is located in Polk County, Iowa. All of the project lands are on Sponsor-owned fee lands or levee easement lands accept for four private small ownerships that the Sponsor will acquire for project needs. A full description of the project area and Real Estate information is noted in the attached Real Estate Plans, included as Appendix F, Real Estate.

7.B.6. Environmental Requirements

A Clean Water Act (CWA), Section 404(b)(1) Evaluation has been prepared since dredged or fill material would be placed in the waters of the United States during the period of construction. This report fulfills those requirements. Unavoidable adverse impacts resulting from the placement of dredged or fill material in the waters of the United States will be mitigated to the extent appropriate and practicable, to demonstrate compliance with the CWA Section 404(b)(1) Guidelines. State water quality certification is required prior to construction, in compliance with CWA Section 401.

An archeological survey of the study areas was performed in accordance with the National Historic Preservation Act. If cultural resources are discovered during construction and cannot be avoided, work will be suspended in that area until the properties are evaluated for eligibility for listing in the National

Register of Historic Places in consultation with the Iowa State Historic Preservation Officer (SHPO). If the properties are determined to be eligible, the effects of the proposed construction will be taken into consideration in consultation with the SHPO; and the Advisory Council on Historic Preservation will be provided the opportunity to comment.

As stated earlier, Clean Water Act Section 404 and 401 permits will be required prior to construction of Reach 1 Birdland levee, due to approximately 1.6 to 2.5 acres of wetland impacts and 2.7 to 3.8 acres of open water impacts from construction of the levee. In addition, Clean Water Act Section 404 and 401 permits will be required prior to construction of Reach 2 Central Place levee. This is due to approximately 1.2 acres of wetland impacts from construction of the levee.

No 404 or 401 permits are expected to be required for the Downtown closure structures, since no wetland or open water areas are expected to be impacted.

7.B.7. Sponsorship Agreements

The City has provided a Letter of Intent acknowledging Sponsorship requirements for the Des Moines and Raccoon Rivers Project. Prior to construction, the Sponsor will be required to enter into an agreement with the Federal Government that it will comply with Section 221 of the Flood Control Act of 1970 (P.L. 91-611), and the Water Resources Development Act of 1986 (P.L. 99-662), as amended.

8. SUMMARY of COORDINATION, PUBLIC VIEW, and COMMENTS

8. A. COORDINATION

The Des Moines and Raccoon Rivers Feasibility Study was conducted as a partnership between the City and the District. This partnership included extensive coordination with numerous groups including federal, state, county, and city agencies; neighborhood associations; businesses; landowners; the media; and the unaffiliated public. These groups also were included on the study's distribution list of approximately 300 interested parties.

Appendix H, *Public and Agency Coordination*, contains detailed information about how the outreach activities listed below were an integral part of the public involvement plan:

- Study Newsletters: Feb 2000; Jan and Dec 2002; March 2004
- Study website: http://www.mvr.usace.army.mil/DesMoinesFP/
- Public Open house: Jan 2003
- Initial coordination letter to resource agencies
- USFWS

The USFWS has no objection to the selection of the preferred alternative of improvements to the existing Birdland Park and Central Place levee systems, installation and construction of downtown closure structures, and implementation of the comprehensive mitigation plan on-site at Central Place and off-site at the Chichaqua mitigation area.

8.A.1. State Historic Preservation Officer

The District determined that the proposed flood control measures of the preferred plan would have No Effect on historic properties. This determination was provided to the SHSI and interested public for review and comment by letter dated July 21, 2004. The SHSI concurred with a portion of the District's determination by letter dated August 9, 2004 (R&C#: 000377008). The SHSI concurred with the "No Effect" determination as it pertained to Reach 1, Reach 2, and those project features located outside of

known historic district and individual historic property boundaries. The SHSI recommended a "No Adverse Effect" determination for those project features within known historic property boundaries in Reaches 3, 4, and 5. The Otoe-Missouria Tribe notified the District by letter dated August 26, 2004 that they had no knowledge of properties within the project "Area of Potential Effect" but that they would like to be notified in the event of inadvertent discoveries during project construction. No additional historic properties or concerns were identified as a result of the consultation.

8.A.2. Iowa Department of Natural Resources (Iowa DNR)

The Iowa DNR would like the District to investigate mitigation within the Des Moines River watershed or explain in the EA why it is not practicable. If mitigation occurs in a nonadjacent area as it does with the Chichaqua site, the Iowa DNR would prefer that the "mitigation ratio" is greater than 1 to 1. In addition, any mitigation plan should include all three types of wetlands being impacted (emergent, scrub-shrub, and bottomland forest) and provide as much in-kind mitigation as possible, taking into consideration the maturity and diversity of the wetland being impacted.

8.A.3. Federal Emergency Management Agency (FEMA)

The Federal Emergency Management Agency was made aware of all the hydrology and hydraulic studies throughout the study's process. Currently FEMA is digitizing existing Flood Insurance Flood Rate Maps in the Des Moines area.

8. B. SUMMARY OF PUBLIC INVOLVEMENT

The goals of the public involvement and coordination process were met via the varied public involvement activities throughout the study. Numerous publics (listed in the coordination paragraph above) were identified as target audiences for public involvement and coordination. Newsletters, the study's website, and an open house were vehicles used to inform, educate, and involve the public and offer them opportunities to provide feedback to the study team. The feedback was gathered into a content analysis report and used by the study team to shape the plan formulation process and to develop the recommended plan.

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9. RECOMMENDATIONS

The Great Flood of 1993 demonstrated the need for improved flood protection for the City of Des Moines. The Birdland Park and Central Place levees do not meet Federal standards and do not provide a certifiable level of protection. The existing federal levees protecting the downtown areas do provide a certifiable level of protection; however improvements to the levee closures would substantially increase the reliability of these levees.

I have considered all significant public interest aspects of the recommended plan for flood damage reduction and associated recreation developments at Des Moines, Iowa. This multi-purpose project is feasible from an economic, engineering, environmental, and social perspective. The recommended plan will provide reliable permanent flood protection and improved recreation opportunities for nearly 200,000 citizens of Des Moines and will provide average annual net National Economic Development benefits of over $1 million. The total cost to implement the recommended project is $10,491,000* of which an estimated $3,709,000* would be the Local Sponsor's responsibility.

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. However, prior to transmittal to the Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

The Local Sponsor understands its responsibilities as discussed in Section 7.B above and has indicated its willingness to execute a Project Cooperation Agreement with the Federal Government for implementation of the recommended plan. I recommend approval of the recommended plan as presented in this report, with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable.

9/16/2005
(Date)

Melody D. Smith
Major, U.S. Army
Acting District Engineer

* updated to Oct 05 prices, 5-1/8%

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VOLUME 2

APPENDICES

December 2005

US Army Corps
of Engineers
Rock Island District

(115)

38307

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
CLOCK TOWER BUILDING P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

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DES MOINES/RACCOON RIVERS FEASIBILITY REPORT
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I. SCOPE

This appendix summarizes the results of various analyses prepared for the Des Moines and Raccoon Rivers feasibility study. It documents the assumptions used in hydrologic and hydraulic computations that were conducted from 2001 through 2003 to determine whether flood related problems within the City of Des Moines (City) warranted Federal action. The study area is defined in detail in the main report and discussed in the next section. The streams examined include: Des Moines River, Raccoon River, Walnut Creek (a small tributary to the Raccoon River), Fourmile Creek (a small tributary of the Des Moines River), and Leetown Creekway (a small urban tributary to Fourmile Creek).

Design discharges and verification work are discussed in Section II, Discharge Hydrology. Section III, Interior Flood Hydrology, summarizes interior flood hydrology studies for the interior areas of Birdland and Central Place. It also contains work on the influence of the proposed levee separating Leetown Creekway from Fourmile Creek. Add 773.84 feet to elevations in City Datum to convert them to NGVD in feet.

HEC-RAS models used to compute water surface profiles are summarized in Section IV, Hydraulics. Plotted profiles appear as plates at the end of this appendix, while inundation maps are contained on the attached compact disk.

During the 1950s, the City of Des Moines built the first levees along the Des Moines and Raccoon Rivers. Some were upgraded after 20 years. The average annual damages for the existing systems were computed using the HEC-FDA (Flood Damage Analysis) program. The hydrologic and hydraulic input to this model is discussed in Section V, Flood Damage Analysis, along with the computed levee performance. The discussion of geotechnical levee failure appears in Appendix J, *Geotechnical*. The discussion of economic data and output is addressed in Appendix B. HEC-FDA was also used to evaluate increasing the height of levees and to evaluate improving existing closure structures. HEC-FDA was used to evaluate a proposed levee along the left bank of Walnut Creek (vicinity of Grand Avenue). See main report for definition of alternatives.

1. Study Area

The Raccoon River joins the Des Moines River within the City of Des Moines. The two rivers divide the city into three parts. The rivers have drainage areas in the range of 3,000 to 5,000 square miles. Both existing levees and Saylorville Reservoir reduce flood damage within the City. The reservoir is about 10 miles upstream of the City on the Des Moines River. The dam for the reservoir was closed in 1975 and the reservoir placed in operation in 1977 (reference 1). Walnut Creek and Fourmile Creek have drainage areas around 100 square miles. The lower reaches of these smaller streams flow through developed areas and the channels have been straightened and

enlarged. A levee currently exists along the right bank of Walnut Creek (for the City of West Des Moines). There are no levees on Fourmile Creek.

II. DISCHARGE HYDROLOGY

1. Adopted Discharge-Frequency Values

The discharge-frequency values for the Des Moines and Raccoon Rivers appear in table A-1; similar values for Fourmile Creek and Walnut Creek appear in table A-2. All discharges are in cubic feet per second (cfs). The exceedance probability is the probability that a specific event will occur in any given year; a .01-exceedance probability event has 1 chance in a hundred of occurring in any given year. HEC-FDA uses .004 exceedance probability other programs usually compute the .005 exceedance probability.

Table A-1 Discharge -Frequency Values for Des Moines and Raccoon Rivers

Exceedance Probability	Des Moines SE 14 St CFS	Des Moines 2nd Ave CFS		Raccoon River at Fleur Dr CFS
.50	25,000	14,000		14,400
.20	35,000	18,000		24,400
.10	40,000	19,000		32,400
.04	58,000	25,000		43,000
.02	72,000	30,000		51,900
.01	87,000	37,000		61,300
.004	110,000	45,000		75,000
.002	132,000	52,000		85,900

Table A-2 Discharge -Frequency Values for Fourmile and Walnut Creeks

Exceedance Probability	Fourmile Creek Existing CFS	Fourmile Creek Future CFS		Walnut Creek Existing CFS	Walnut Creek Future CFS
.50	2,330	2,780		2,410	3,000
.20	3,820	4,470		4,850	5,300
.10	4,870	5,640		6,940	7,300
.04	6,230	7,140		10,200	10,500
.02	7,260	8,260		12,800	13,450
.01	8,290	9,380		15,900	17,000
.004	9,650	10,850		20,300	22,500
.002	10,700	12,000		24,300	27,000

The source or the derivation of the discharges and gage locations are discussed in the following section. The drainage areas for the Des Moines and Raccoon Rivers are large enough that urbanization will not increase discharges in the future. The drainage areas for Walnut Creek and Fourmile Creek are small enough that urbanization can increase future discharges (year 2020). Discharges for Fourmile Creek are at Easton Blvd. Discharges at the mouth of Fourmile Creek are reduced by storage for large floods as discussed in the Fourmile Creek section.

2. Source or Derivation of Discharge-Frequency Values

2.1 Des Moines River

Discharge-frequency relationships for the Des Moines River at Des Moines, Iowa, were obtained from a recent study (reference 2) and appear in table A-1. The referenced study was conducted by the Hydrologic Engineering Center in the aftermath of the 1993 flood. Discharges were determined at 2nd Avenue (upstream of the confluence of the Raccoon River) and at South East 14th Street (downstream of the confluence of the Raccoon River). Details concerning the reference can be obtained from the Rock Island District Corps of Engineers.

2.2 Raccoon River

The Raccoon River drains 3,629 square miles. The longest tributary, the North Raccoon River, flows southeasterly for most of the length of the basin. The other tributaries, Middle and South Raccoon Rivers, drain nearly one-third of the basin and join the North Raccoon west of the City of Van Meter. Van Meter is about 17 miles west of the confluence of the Raccoon (with the Des Moines River).

The discharge-frequency values for the Raccoon River at Fleur Drive (tables A-1and A-3) were obtained by adjusting the discharge-frequency values for Van Meter. The discharges used for Van Meter are from the most recent flood insurance study (2000 reference 4). The adjustment factor (1.0335) used to increase the Van Meter discharges is the ratio of the drainage areas at Fleur Drive to Van Meter (3620/3411=1.105) raised to the exponent 0.65. The discharge values were then rounded to the nearest one hundred cfs. The value of the exponent is equal to the drainage area exponent used in state regression equations (reference 5).

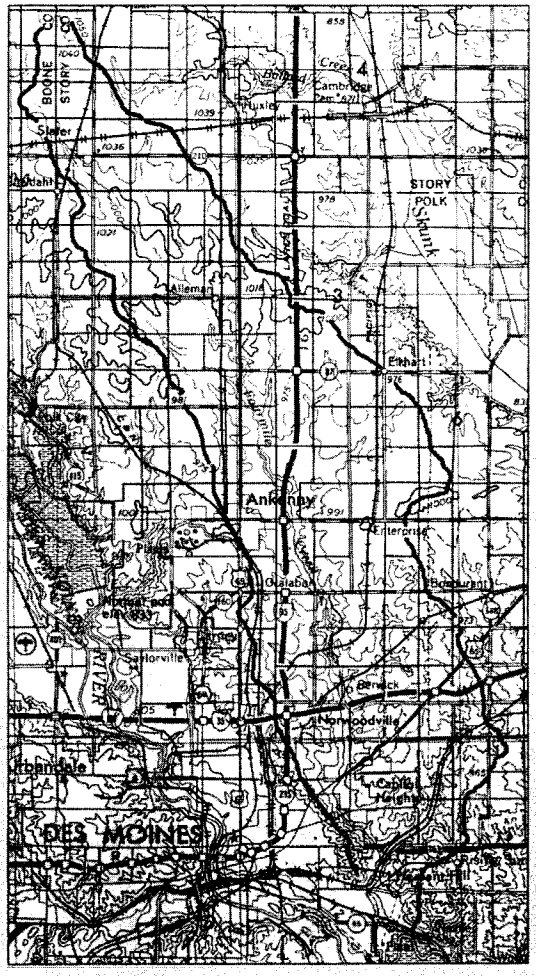
The discharge-frequency values for Van Meter are based on a log-Pearson Type III analysis (reference 3) of annual peak discharges (USGS gage 05484500, 1915 through 1994). The results are listed in table A-3. Before adopting the same values used in the flood insurance study, the flow frequency analysis was recomputed to verify that extending the period of record at Van Meter to 1998 did not change the discharge frequency values significantly. As can be seen in table A-3 the additional peaks increased the .01-exceedance probability event by only 700 cfs. This increase was so small that published flood insurance values were adopted.

Table A-3 Discharge-Frequency Raccoon River- Van Meter to Fleur Drive

Exceedance Probability	Van Meter USGS Gage 1915-1998 CFS	Van Meter USGS Gage 1915-1994 CFS		Adopted (from FIS) Fleur Drive CFS
.10	31,600	31,300		32,400
.02	50,800	50,200		51,900
.01	60,000	59,300		61,300
.005	70,000	69,000		71,300
.002	84,100	83,100		85,900
Drainage area	3441	3441		3620

2.3 Fourmile Creek

Fourmile Creek starts in Boone County, Iowa, and flows south to the Des Moines River. Most of the basin is in Polk County as shown on the map on plate A-1. The only gage is at Easton Boulevard (USGS 05485640) with a drainage area of 92.7 square miles. The distance from the mouth to the gage is 5 miles; the distance from the gage to the basin divide is approximately 26 miles. The soil types in the basin are Clarion, Nicollet, and Webster. These are silty, clay, loam soils with poor to moderate drainage properties.



Basin Map of Fourmile Creek

Plate A-1

2.3.1 Existing Condition Discharges based on Flow Frequency Analysis

The existing condition discharges (tables A-2 and A-4) were calculated by flood flow frequency analysis (HEC-FFA) of observed discharges at the gage (Easton Blvd). The analysis was a log-Pearson Type III analysis (reference 3) of annual peaks using a regional skew of -.4 (from internal Rock Island District regional skew study of 1997). The record included 27 events (1972 through 1999 with data for 1980 missing). The analysis detected and adjusted for one low outlier. The synthetic statistics and "computed" discharge values appear in table A-4.

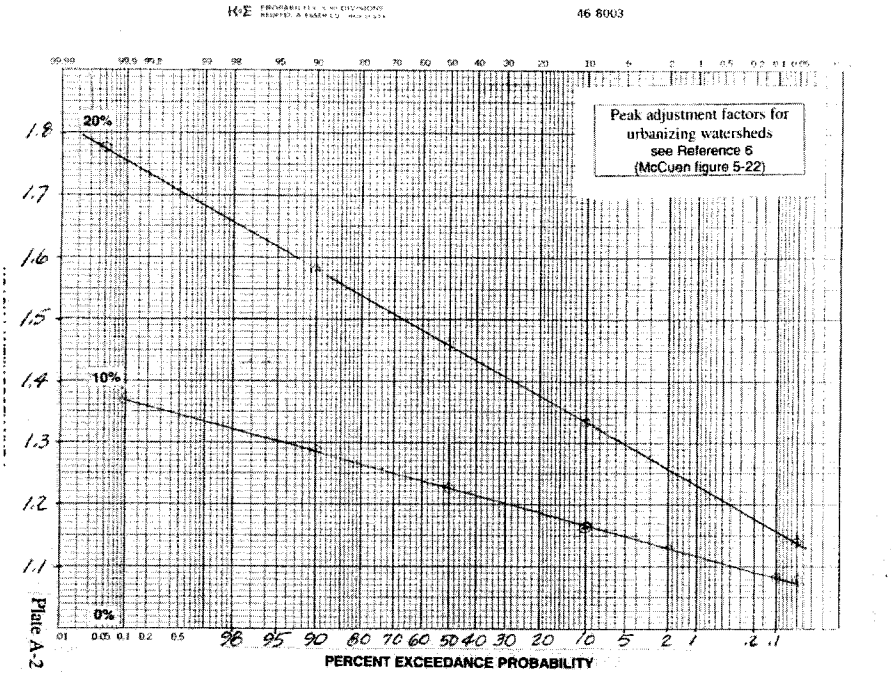
Table A-4 Existing Condition Flood Frequency Analysis Summary for Fourmile Creek

Exceedance Probability	Computed Flow CFS		Synthetic Statistics	
.50	2,330		Mean Log	3.3536
.20	3,820		Standard Deviation	.2684
.10	4,870		Computed Skew	-.1205
.05	5,900		Regional Skew	-.4
.02	7,260		Adopted Skew	-.3
.01	8,290		Systematic Events	27
.005	9,320		Low Outliers	1
.002	10,700			

2.3.2 Future Condition Discharges based on Flow Frequency Analysis using Adjusted Peak Discharges

The future condition discharges shown in table A-6 (also table A-2) were calculated by flood flow frequency analysis (HEC-FFA) using adjusted discharges from the same Easton gage.

The adjustment for future conditions shown on page A-8 followed FEMA guidance in *Hydrologic Analysis and Design* (reference 6). Using this method, the observed discharges are adjusted for future impervious conditions; then the adjusted peak discharges are analyzed with HEC-FFA. The adjustment factor for each discharge depends upon the change in imperviousness and the exceedance probability of that discharge. Plate A-2 shows the adjustment chart for impervious values of 10 and 20 percent taken from Figure 5-22 in reference 6. The adjustment factors for impervious values of 7 percent and 17 percent were interpolated from this plot and appear in table A-5. Each annual peak was adjusted back to a rural condition by dividing it by the factor representing the imperviousness of basin when the peak was observed (7 percent) and then adjusted forward to the future condition (17 percent) by multiplying it by a second factor representing the future imperviousness of the basin.



Several tests were made upon the observed peak discharges to test for randomness. The data passed the random test indicating that no dramatic changes in imperviousness have occurred between 1972 and 1999. Several sensitivity tests were made to see if a value 6 percent would produce different answers. The answers differed by less than one percent.

Table A-5 below lists the observed and adjusted peak discharges. The plotting position used for the exceedance-probability was computed by dividing the rank by a number equal to one plus the total number of observed events (in this case 27+1=28).

Table A-5 Observed and Adjusted Annual Peak Discharges for Fourmile Creek

Water Yr	Observed Peak	Rank	exceed. prob.	Correction Factor 7%	Correction Factor 17%	Adjusted Peak
1972	1440	21	0.750	1.1799	1.4432	1761
1973	2600	11	0.393	1.1491	1.3649	3088
1974	5340	3	0.107	1.1190	1.2855	6135
1975	1820	16	0.571	1.1638	1.4034	2195
1976	4440	5	0.179	1.1288	1.3142	5169
1977	5380	2	0.071	1.1120	1.2685	6137
1978	1900	15	0.536	1.1610	1.3938	2281
1979	1470	20	0.714	1.1764	1.4333	1791
1981	1260	23	0.821	1.1876	1.4626	1552
1982	4800	4	0.143	1.1239	1.3009	5556
1983	4080	8	0.286	1.1400	1.3421	4803
1984	3720	9	0.321	1.1442	1.3516	4394
1985	1160	24	0.857	1.1925	1.4745	1434
1986	3420	10	0.357	1.1470	1.3591	4052
1987	2490	12	0.429	1.1526	1.3741	2969
1988	250	27	0.964	1.2170	1.5361	316
1989	731	26	0.929	1.2058	1.5075	914
1990	4410	6	0.214	1.1330	1.3244	5155
1991	1520	19	0.679	1.1729	1.4255	1847
1992	1350	22	0.786	1.1834	1.4524	1657
1993	4210	7	0.250	1.1372	1.3339	4938
1994	779	25	0.893	1.1974	1.4871	967
1995	1540	18	0.643	1.1701	1.4187	1867
1996	2110	14	0.500	1.1575	1.3881	2530
1997	1550	17	0.607	1.1673	1.4112	1874
1998	5600	1	0.036	1.1008	1.2413	6315
1999	2440	13	0.464	1.1547	1.3813	2919

Table A-6 Future Condition Flood Frequency Analysis Summary for Fourmile Creek

Exceedance Probability	Computed Flow CFS		Synthetic Statistics	
.50	2,780		Mean Log	3.4314
.20	4,470		Standard Deviation	.2570
.10	5,640		Computed Skew	-.1349
.05	6,780		Regional Skew	-.4
.02	8,260		Adopted Skew	-.3
.01	9,380		Systematic Events	27
.005	10,500		Low Outliers	1
.002	12,000			

2.3.2.1 Imperviousness Values used to adjust discharges for Fourmile Creek

City maps for Des Moines, Ankeny, and Altoona, in addition to a map of Polk County, were used to estimate impervious percentages for the basin of Fourmile Creek. Impervious percentages were estimated for 2002 (7 percent) and for 2020 (17 percent). The computations were based upon official planning maps and documents provided by the City. The impervious percentages assigned to various land uses for the evaluation appear in table A-7.

Table A-7 Impervious Values Assigned to Land Use Categories

Description	ID	Imp	Lot Size
Very Low Density Residential	VLDR	20%	>1/2 Ac
Low Density Residential	LDR	40%	>1/6 Ac
Medium Density Residential	MDR	65%	>1/8 and <1/17 Ac
High Density Residential	HDR	70%	<1/17 Ac
Business Park	BP	84%	
Commercial	C	84%	
Industrial	I	72%	
Office/ Industrial	O/I	84%	
Public	P	72%	
Park	Pk	3%	
Rural Land		2.5%	

Existing and future impervious percentages for areas designated as Ankeny, Altoona, and Des Moines were computed from each individual city map. The city impervious value was the total of the weighted impervious values within each city. Each weighted value was the product of the impervious value for a specific land use times its area divided by the total city area. The computations are summarized in table A-8.

A Polk County map (1 inch equal to 4,000 feet) was used to measure the area of each city and of each land use region of Polk County within the basin. The basin impervious value was the total of the weighted impervious values within the various regions. Each weighted value was the product of the impervious value for a specific city or region times the area of the region divided by the total basin area. The computations are summarized in table A-8. Parts of areas in Polk County designated as VLDR and LDR (table A-7) were included in calculations for Ankeny. Another area in Polk County designated LDR was included in calculations for Des Moines.

Table A-8 Existing and Future Impervious Percentages for Fourmile Creek Basin

ID	Existing Impervious (%)	Existing Area (Sq. Mi.)	Existing Weighted Value	Future Impervious (%)	Future Area (Sq. Mi.)	Future weighted value
Slater	25	0.29	0.08	25	0.29	0.08
Alleman	25	0.19	0.05	25	0.19	0.05
Elkhart	25	0.14	0.04	25	0.14	0.04
County I (blue)	25	1.62	0.44	72	1.62	1.26
County Pk (green)	3	3.68	0.12	3	3.18	0.10
County C (pink)	25	0.79	0.21	84	0.79	0.72
County VLDR (yellow)*	3	4.58	0.15	20	4.58	0.99
County LDR (tan)*	40	1.08	0.47	40	1.58	0.68
Ankeny	19	12.18	2.50	57	12.18	7.49
Altoona	3	1.96	0.06	65	1.96	1.37
Des Moines	21	5.75	1.30	45	5.75	2.79
Rural remainder	2.5	60.44	1.63	2.5	60.44	1.63
	Total=	92.7	**7.04**	Total=	92.7	**17.20**

2.3.2.2 Discharges for Fourmile Creek at Points other than Gage

Discharges at Hubbell, University, and Scott were computed by applying a factor to discharges computed at the Easton gage (existing table A-4 and future table A-6). The adjustment factor was the drainage area ratio (area at desired point divided by drainage area at gage) raised to an exponent. The exponent was equal to the "area exponent" of state regression equations of Region 2 from reference 7. The drainage areas at points upstream and downstream of Easton Boulevard were measured from 1:24000 USGS quadrangle maps and appear in table A-9. These discharges have been rounded to the nearest ten cfs.

Table A-9 Discharges in Cubic Feet Per Second for Points along Fourmile Creek

Bridge Location	Drainage Area	Exceedance Probability							
		.50 Exist.	.20 Exist.	.10 Exist.	.04 Exist.	.02 Exist.	.01 Exist.	.004 Exist.	.002 Exist.
Hubbell	89.9	2,290	3,760	4,800	6,150	7,170	8,180	9,530	10,570
Easton	92.7	2,330	3,820	4,870	6,230	7,260	8,290	9,650	10,700
University	95.7	2,370	3,880	4,940	6,320	7,360	8,400	9,780	10,830
Scott	108.4	2,540	4,120	5,240	6,680	7,760	8,850 ~~9,130~~	10,280	11,370 ~~11,710~~
RR d/s Scott	117	2,640	4,280	5,430	6,900	8,020	7,740r	~~10,600~~	9,860r
		Fut.	**Fut.**	**Fut.**	**Fut.**	**Fut.**	**Fut.**	**Fut.**	**Fut.**
Hubbell	89.9	2,730	4,400	5,560	7,040	8,150	9,260	10,720	11,860
Easton	92.7	2,780	4,470	5,640	7,140	8,260	9,380	10,850	12,000
University	95.7	2,830	4,540	5,720	7,240	8,370	9,500	10,990	12,150
Scott	108.4	3,020	4,830	6,070	7,650	8,830	10,010	11,560	12,750
RR d/s Scott	117	3,150	5,010	6,280	7,910	9,120	~~10,330~~	~~11,920~~	~~13,140~~
Exponent=		.540	.490	.465	.441	.427	.415	.403	.389

(r means discharge reduced by storage)

The starting discharges (RR d/s Scott) for exceedance probabilities of .01 and .002 are based upon a HEC-HMS routing. This routing is discussed under Interior Flood Hydrology (Fourmile Creek Project Impacts). The routing was made for existing case discharges only.

2.3.3 Discharges Computed for Fourmile Creek by Other Methods

Discharges were also computed at the Easton gage using both state regression equations and HEC-HMS models. This work confirmed the adopted discharges and is summarized in the following paragraphs.

Discharge frequency values for Fourmile Creek were published in a 1988 flood insurance study (reference 8). The discharges for an area of 93 square miles appear to be a combination of region II and I from 1973 state regression equations (reference 9) and appear in table A-10.

Table A-10 Previous Reported Discharges for Fourmile Creek

Exceedance Probability	1988 FIS Peak Flow CFS
.10	3,120
.02	5,170
.01	6,140

State Regression Equations

Discharges for the existing conditions were computed using 1987 state regression equations (reference 5). Values were rounded to the nearest 100 cfs. Fourmile Creek is on the boundary of regions 3 and 4 but its characteristics are those of region 3. Region 4, the Des Moines lobe, contains sluggish streams with slopes from 2 to 4 feet per mile. The slope of Fourmile Creek (10 percent to 85 percent of distance from gage to basin divide) is about 8.7 feet per mile. For this reason, the equations for region 3 were used. The discharges computed for a drainage area of 92.7 square miles and appear in table A-11.

Future condition discharges were obtained by adjusting discharges for a rural basin for urbanization (reference 10). The three-parameter equation used to adjust peak discharge includes drainage area, a basin factor that evaluates manmade changes to the drainage system, and the equivalent rural peak discharge. The average error of the method is about +/- 45 percent. The basin development factor (BDF) is determined by evaluating each third of the basin; the factors for each third are totaled to form the basin development factor. A value of zero for a basin indicates no development while 12 indicates full development. At Fourmile Creek, most development is in the lower third of the basin, between the mouth and Ankeny. No adjustments were made for the other two thirds of the basin. The future condition discharges were computed with a basin development factor of 1 and appear in table A-11.

Table A-11 State Regression Equation Discharge Data for Fourmile Creek

Exceedance Probability	Existing Condition CFS	2020 (BDF=1) CFS
.50	2,100	3,200
.20	3,800	5,400
.10	5,000	6,700
.04	6,700	8,500
.02	8,000	10,400
.01	9,400	12,400

HEC-HMS Modeling

Existing-condition discharges were calculated with HEC-HMS (reference 11). The basin was modeled at the gage as one sub-basin (92.7 sq. mi.) using data from reference 12 and rainfall from reference 13. Observed hydrographs were optimized for Clark's time of concentration (Tc) and storage (R). The best fit was a time of concentration of 9 hours and a Clark's R of 12 hours. Future condition discharges were also computed. Since the computations were not used for design, only the results are summarized (table A-12). Details can be obtained from the Rock Island District Corps of Engineers.

Table A-12 HEC-HMS Discharge-Frequency Relationship for Fourmile Creek

Exceedance Probability	Initial Loss Inches	Existing Peak Flow CFS	2020 Peak Flow CFS
.50	1.5	2,100	2,700
.20	1.5	3,900	4,700
.10	2.0	4,800	5,800
.04	1.75	6,400	7,600
.02	2.2	7,800	9,200
.01	2.4	9,200	10,800

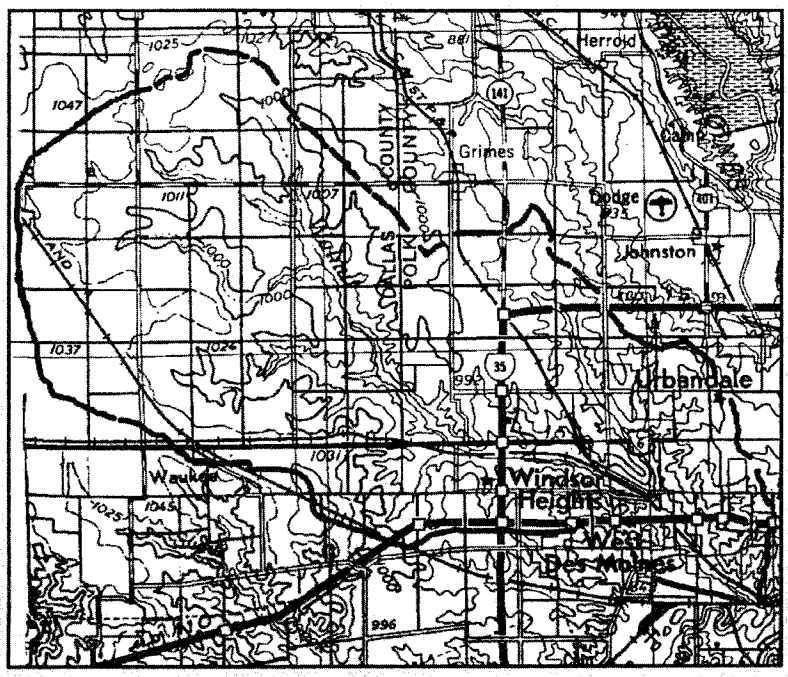
2.4 Walnut Creek

The HEC-FFA results were used for the existing condition. The current regulatory discharges (which include urbanization) were used for the future condition.

Walnut Creek flows southeast into Polk County from its headwaters (about half the drainage area) in Dallas County, Iowa. The basin is shown on plate A-3. The gage (USGS 05484800) is 2.2 miles upstream from the mouth and 24 feet downstream of 63rd Street Bridge. The drainage area is 78.4 square miles. The distance from the gage to the basin divide is about 20.5 miles with a slope of about 8.3 feet per mile (from 10 percent to 85 percent of distance from gage to basin divide). The soil types adjacent to the creek are Clarion-Webster-Storden and in the upland areas Canisteo-Clarion-Nicollet. The soil data was obtained from a 1983 USDA soil survey of Dallas County, Iowa.

2.4.1 Existing Condition Discharges based on Flow Frequency Analysis

The discharge frequency relationship for the existing condition is from a Flood Frequency Analysis (HEC-FFA) of gage (05484800). The program is based on log-Pearson Type III analysis (reference 3) of annual peak discharges. The analysis used discharges from 1972 through 1999 and a regional skew of -0.4. The "computed" discharge values along with the synthetic statistics appear in table A-13 (and A-2).



Basin Map of Walnut Creek

Plate A-3

Table A-13 Existing Condition Flood Frequency Analysis Summary for Walnut Creek

Exceedance Probability	Computed Flow CFS		Synthetic Statistics	
.50	2,410		Mean Log	3.3760
.20	4,850		Standard Deviation	.3662
.10	6,940		Computed Skew	.2716
.02	12,800		Regional Skew	-.4
.01	15,900		Adopted Skew	-.1
.005	19,300		Systematic Events	28
.002	24,300		Outliers	None

2.4.2 Future Condition Discharges based on Regulatory Discharges

The discharge-frequency relationship for the future condition used the current regulatory discharges. The regulatory discharges were established in 1975 when the Iowa Natural Resources Council (INRC), the United States Geological Survey, and the Corps of Engineers Rock Island District met at the request of local communities along Walnut Creek. The communities wanted one discharge relationship that reflected the urban nature of the Des Moines metropolitan region and considered the potential for development. This regulatory relationship was obtained by increasing the discharges computed using the then current state regression equations (Bulletin 11 reference 9). Each regulatory discharge was equal to the computed discharge plus one standard error of the discharge. This standard error is further discussed in reference 9 (Table 1, Region I, model 2). The computations used an area of 82.4 square miles and a channel slope of 10.5 feet per mile. Results from the equations and the adjustment are reprinted in table A-14. The regulatory discharges were published in reference 14 and have been used in all subsequent flood insurance studies (Clive, West Des Moines, Windsor Heights, and Des Moines) and by the Corps of Engineers in flood reduction studies on Walnut Creek.

Table A-14 Walnut Creek Derivation of Regulatory Discharges

Exceedance Probability	Bulletin 11 Peak CFS	Std Error	Peak times (1+std Error) CFS	Regulatory Peak (1975) CFS
.50	2,175	.40	3,050	3,000
.20	4,150	.29	5,350	5,300
.10	5,370	.26	7,220	7,300
.04	7,990	.31	10,460	10,500
.02	9,850	.37	13,490	13,450
.01	11,800	.44	17,000	17,000

2.4.3 Discharges Computed for Walnut Creek by Other Methods

State Regression Equations

Discharges were computed using 1987 state-regression-equations (reference 5) and adjusted to estimate existing and future condition discharges.

Walnut Creek is on the boundary of hydrologic Regions 3 and 4. Region 4 covers the Des Moines lobe and is representative of sluggish streams. These streams have slopes from 2 to 4 feet per mile. The slope of Walnut Creek is similar to streams in Region 3. For this reason, Region 3 equations

were used exclusively. Computed discharges for a rural basin using the area of 78.4 square miles appear in table A-15. These discharges were then adjusted (reference 10) to estimate existing and future condition discharges.

The existing condition used a basin development factor (BDF) of 1. At present, about 60 percent of the lower third of Walnut Creek is developed. This produces a total basin development factor of 1. The future condition used a basin development factor of 3. It was produced by assuming that the same lower third of Walnut Creek will experience more channel straightening along the main channel. During the same period, more secondary tributaries will be conveyed in storm drains and sewers in the lower third of the basin. This will increase the total basin development factor to 3. Results appear in table A-15.

Table A-15 State Regression Equation Discharge Data for Walnut Creek

Exceedance Probability	State Equation Peak Flow CFS		Existing (BDF=1) CFS	Future (BDF=3) CFS
.50	1,900		2,800	3,100
.20	3,500		4,900	5,200
.10	4,600		6,100	6,500
.04	6,100		7,700	8,200
.02	7,300		9,400	10,000
.01	8,600		11,200	11,900

HEC-HMS Modeling

Existing-condition discharges were calculated with HEC-HMS (reference 11) by modeling the basin at the gage as one sub-basin (78.4 sq. mi.). The model used data from references 15 and 16 and rainfall data from reference 13. The unit graph parameters (Clark's Tc of 7.5 hours and R of 7.5 hours) were obtained from reference 15. Observed hydrographs were also used to verify time of concentration (Tc) and storage (R). Future condition discharges were also estimated. Since this work was not used for design, only the results are summarized in table A-16. Details can be obtained from the Rock Island District Corps of Engineers.

Table A-16 HEC-HMS Discharge-Frequency Data for Walnut Creek

Exceedance Probability	Initial Loss Inches	Existing Peak Flow CFS	Future Peak Flow CFS
.50	1.5	2,600	3,400
.20	1.5	4,800	5,700
.10	1.75	6,000	6,900
.04	2.0	7,900	9,000
.02	2.2	9,600	10,800
.01	2.4	11,300	12,600

III INTERIOR FLOOD HYDROLOGY

1. Rainfall Data

Synthetic Rainfall from reference 13 (Region 5 Central Iowa) was used to prepare rainfall input in the Interior Flood Hydrology computer program (reference 17). Partial duration rainfall for 0.5, .2-, and .1 exceedance probability events were adjusted to annual duration within HEC-IFH. Since rainfall data did not exist for the .002 exceedance probability storm it was extrapolated. The data for the durations of four and seven day required for HEC-IFH were also interpolated from data for three, five, and ten days from reference 13. The data used in the model appear in table A-17.

Table A-17 Synthetic Rainfall used for the Des Moines Area

Storm Duration	Exceedance Probability of Storm						
	.5	.2	.1	.04	.02	.01	.002
	Inches	Inches	Inches	Inches	Inches	Inches	Inches
5 min	.35	.44	.51	.62	.70	.79	.99
15 min	.79	.98	1.15	1.39	1.58	1.78	2.2
1 hr	1.37	1.71	2.01	2.42	2.76	3.11	3.9
2 hr	1.69	2.11	2.48	2.99	3.40	3.83	4.8
3 hr	1.86	2.33	2.73	3.30	3.76	4.23	5.3
6 hr	2.18	2.73	3.20	3.86	4.40	4.96	6.2
12 hr	2.53	3.17	3.71	4.48	5.11	5.75	7.1
1 day	2.91	3.64	4.27	5.15	5.87	6.61	8.2
2 day	3.13	3.93	4.67	5.75	6.52	7.33	9.1
4 day	3.76	4.68	5.45	6.57	7.52	8.65	10.6
7 day	4.51	5.45	6.32	7.60	8.65	9.86	12.10
10 day	5.20	6.22	7.22	8.61	9.66	10.88	13.50

2. BIRDLAND

Alternatives 1B, 1C and 1D will divide the Riverside Lagoon. If an alternative stops all seepage out of the landside lagoon, it could increase water levels on the inside lagoon. HEC-IFH was used to model the influence of pumping upon water surface elevations of the portion of the lagoon located landside of the levee. The model used synthetic rainfall with a 10-day duration to compute stage-frequency curves for no pump and for one 5,000-gallons per minutes (gpm) pump. A review of this data showed that pumping was not justified. Other areas were not examined since the city has built two pump stations.

2.1 Birdland HEC-IFH Model

An area of about 0.1 square miles drains into the proposed inside lagoon. This drainage area was divided into upper and lower sub-basins. The area north of the lagoons, called the upper sub-basin, used an impervious percentage of 38 percent (similar to Central Place) based on housing density. The area adjacent to the lagoon, called the lower sub-basin, was assigned an impervious percentage of 67 percent. This area is composed of the following: water (9 acres at 100 percent impervious), grass (5 acre at 0 percent), and commercial development (13 acres at 70 percent). Travel times (Clark's time of concentration, Tc) for the two basins were estimated by dividing the flow length by flow velocity in a street. The velocities of various segments along the flow path were computed using Manning's equation. Clark's R was set equal to Tc. Loss rates were taken from HMS

calibration runs of Fourmile Creek for the .10-exceedance probability event. In order to run the 10-day event, it was necessary to increase the computation interval from 5 to 15 minutes. Since this analysis is concerned with volume, not peak flow, this change did not introduce a significant error. Parameters are summarized in table A-18.

Table A-18 Basin Parameters for the Birdland HEC-IFH Model

Variable	Lower	Upper
Drainage Area Mi2	.04	.06
Impervious Percent	67	38
Initial Loss	1.2	1.2
Uniform Loss	.2	.2
Clark R	.25	.25
Clark Tc	.25	.25

The part of the Riverview Lagoon that is landward of the proposed levee will become the interior pond area and receive all runoff under the proposed alternative. The estimated area-elevation data for this condition was measured from mapping based on 1997 aerial photographs at a scale of 1 inch equal to 300 feet. The area and volume relationship for the with-project condition appears in table A-19. Elevations are in city datum (to convert city datum elevations to NGVD add 773.837 feet).

Table A-19 Elevation-Area-Volume table Riverview Lagoon

	Existing	Existing
Elevation	Area	Volume
Feet	Acres	Ac-feet
16	8.4	0
18	8.7	17.1
20	9.0	34.8
22	12.6	56.4
28	15.3	140.1

At the time this analysis was conducted, the alternative did not include gravity outlets. Gravity outlets may be added later. The results represent the highest possible water levels since gravity outlets would result in lower water levels. There will be a gated culvert connecting the two parts of the lagoon. The HEC-IFH analysis used a starting water level of 18 feet and a Des Moines water level of 22 feet. The model used a pump capacity of 5,000 gpm with a pump on elevation of 17.9 feet and a pump off elevation of 18.1 feet.

2.2 Birdland HEC-IFH Results

Annual series results of lagoon stage versus frequency appear on table A-20. The rainfall increments were arranged in a triangular pattern with the highest values closest to the center. The analysis incorporated peak rainfall amounts ranging from 15-minute to 10-day durations. Elevations are in city datum. Computations assumed that the starting pond elevation was 18 feet; alternate starting levels were not examined.

Table A-20 Interior Flood Hydrology Results for Birdland at Riverside Lagoon

Storm Exceedance Probability	Maximum Interior Elevation No Pumps	Maximum Interior Elevation 5,000 gpm
.5	19.0	18.5
.2	19.6	18.8
.1	19.9	19.2
.04	20.4	19.6
.02	20.8	19.8
.01	21.1	20.2
.002	22.2	20.7

3. CENTRAL PLACE

All interior runoff from the area protected by the existing Central Place levee is removed by existing pumps; there are no gravity drains. Some water is intercepted and diverted to the Des Moines River; the rest is pumped from four pump stations. This analysis examined putting a storage pond at the inlet to the Indiana Street pump station. The HEC-IFH model used synthetic rainfall to compute interior stage frequency tables for the existing case and for the with-pond case. While the pond eliminated nuisance flooding there was not economic justification for it and the city developed the property for other purposes.

3.1 Central Place HEC-IFH Model

An area of 0.75 square miles contributes runoff to Central Place. This area was divided into two sub-basins for modeling in HEC-IFH. The area west of 2nd Avenue, called the upper sub-basin, was assigned an impervious percentage of 38 percent. The imperviousness was estimated using an average lot size of one-quarter acre and tables from reference 12. The area east of 2nd Avenue and landward of the levee, called the lower sub-basin, is predominately commercial, and was assigned an impervious value of 73 percent. Travel times (Clark's time of concentration, Tc) for both sub-basins were estimated by dividing the flow length by flow velocities in streets. The velocities of various segments along the flow path were computed using Manning's equation. Clark's R was set equal to Tc. Loss rates were taken from calibration runs made for Fourmile Creek using a .10 exceedance probability event. Parameters are summarized in table A-21.

Table A-21 Basin Parameters for the Central Place HEC-IFH Model

Variable	Lower	Upper
Drainage Area Mi2	.25	.50
Impervious Percent	72	38
Initial Loss	1.2	1.2
Uniform Loss	.2	.2
Clark R	.28	.30
Clark Tc	.28	.30

Interior runoff will collect in the southeast part of the lower sub-basin since this is the lowest point in the basin. The area-elevation data for the interior pond (existing condition) was measured from maps based on 1997 aerial photographs at a scale of 1 inch equal to 300 feet. The without-project elevation-area table appears in table A-22. An elevation-area table was also computed for the proposed pond area (with-project) and appears in the same table. The proposed pond will be near the existing Indiana Street pump station (north of University Avenue). The pond was 238 feet

wide, 508 feet long, bottom elevation of 8 feet, and side slopes of 3h:1v. It held about 22 acre-feet of storage.

Table A-22 Elevation-Area-Volume Table for Central Place

Elevation Feet	Existing Area Acres	Existing Volume Ac-feet		Proposed Area Acres	Proposed Volume Ac-feet
0	0	0		0	0
8.0	0.0	0.0		0.0	0.0
8.1	0.0	0.0		2.7	0.1
14.9	0.0	0.0		3.5	21.2
15.1	1.0	0.1		4.5	22.0
16.0	4.0	2.4		6.3	26.9
17.0	10.0	9.4		10.0	35.0
18.0	31.0	29.9		31.0	55.5
19.0	47.0	68.9		47.0	94.5
20.0	66.0	125.4		66.0	151.0
21.0	85.0	200.9		85.0	226.5
22.0	107.0	296.9		107.0	322.5

As stated earlier, all storm runoff is either diverted or pumped. The City furnished all pump information (table A-23). The data was used to create pump modules for Indiana Street, Clark Street, and Franklin Street pump stations. Elevations are in city datum. Since pump efficiency tables were not available, the computations assumed 93 percent of the rated capacity and an exterior water level of 22 feet.

Table A-23 Pump Table for Central Place

Location	Pump Off elevation	Pump On elevation	1st Pump gpm	2nd Pump gpm	3rd Pump gpm
Indiana, by pond	3	8	32,000	18,000	None
Clark Street	8	13	43,000	22,000	None
Franklin Street	6	11	22,000	11,000	None
2nd Ave	15.6	21.3	41,740	41,740	41,740

Some storm sewers in the upper basin (west of 2nd Avenue) divert water north to the Des Moines River. During high water on the Des Moines River, this storm sewer system and some storm water from the lower sub-basin are evacuated by the 2nd Avenue pump station. Each year more progress is made west of 2nd Avenue in separating the combined sewer system into storm and sanitary systems. When completed, the storm sewer terminating at the 2nd Avenue pump station will divert runoff up to and including the .50 exceedance probability storm. The 2nd Avenue pump station was modeled by diverting all flows from 0 to 280 cfs out of the upper sub-basin (table A-24). Discharges above this amount continue to the lower sub-basin.

Table A-24 Diversion from Central Place Upper Sub-basin

Runoff Inflow in CFS	Diverted Flow in CFS
0	0
2	1
281	280
5,000	281

3.2 Central Place HEC-IFH Results

All pumps stations had auxiliary back up power added after the 1993 flood. Annual series results for synthetic storms for the existing condition and the with-project condition appear in table A-25. Elevations are in City Datum.

Table A-25 Interior Flood Hydrology Results for Central Place Levee System

Exceedance Probability	Maximum Interior Elevation Without project	Maximum Interior Elevation With Project
.50	15.1	9.5
.20	16.6	13.0
.10	17.4	15.1
.04	18.0	17.1
.02	18.4	17.8
.01	18.7	18.2
.002	19.4	19.0

4. Fourmile Creek Project Impacts

Several HEC-HMS models investigated the influence of storage on water levels at the junction of Fourmile Creek and Leetown Creek. The results were used in HEC-FDA to evaluate the existing Red Rock Remedial levee (alternative 12A) and the proposed Leetown Levee (alternative 11B). A preliminary .01-exceedance probability profile for Fourmile Creek at the Red Rock Remedial Levee computed a water surface elevation 787.8 feet (14.09 feet) or 1.5 feet above the design levee elevation of 789.5 feet (15.6 feet). However, the preliminary water surface computations did not include the influence of storage. This section discusses reductions in peak discharge and stage (to 13 feet) due to storage. Building alternative 11B or filling this area will increase flood heights to such an extent that the 11B alternative was abandoned. Add 773.84 feet to elevations in City Datum to convert them to NGVD in feet.

4.1 Fourmile Creek HEC-HMS Model

HEC-HMS modeled the storage upstream of the old Norfolk and Southern Railroad Bridge and downstream of Scott Street Bridge. The model consisted of an inflow hydrograph and a routing to simulate the storage.

The total drainage area of Fourmile Creek and Leetown Creekway upstream of this bridge is about 117 square miles. The inflow hydrograph parameters at the railroad bridge were obtained by adjusting parameters calibrated upstream at the Easton Avenue gage. The basin area was increased from 92.7 to 117 square miles. The time of concentration was changed from 9 to 10.3 hours. The increase represented the additional time necessary for water to travel from Easton Avenue to the railroad bridge, a distance of 24,000 feet at an average channel velocity (from HEC-RAS) of 5 feet per second. The value of R was also increased 14 percent. The adopted parameters appear in table A-26.

Table A-26 HEC-HMS Parameters for Fourmile Creek at N&S Railroad Bridge

Variable	Basin
Drainage Area Mi2	117
Impervious Percent	7
Uniform Loss	.15
Clark R	10.3
Clark Tc	13.8

The analysis used rainfall amounts (reference 13) with durations from 1 hour to 1 day from table A-17. The HEC-HMS model arranged the rainfall increments in a triangular pattern with the highest values closest to the center. The initial loss rate was varied until the computed peak agreed with the adopted peak from table A-9.

A Modified-Puls routing was used to simulate overbank and gravel pit storage. The area data from 0 to 12 feet (city datum) was measured from 2-foot contour maps at a scale of 1 inch equal to 500 feet. The maps were made from 2002 aerial photographs. Areas above elevation 12 feet were measured from U.S.G.S quadrangle maps (1 inch equal to 2,000 feet).

The existing gravel pit, west of Fourmile Creek, has a surface area of about 86 acres between elevations 2 to 10 feet. Since the original ground elevation around the pit varies from 9 to 10 feet, water does not enter the gravel pit until the water level upstream of the railroad bridge goes over the bank. This was modeled (table A-27) by omitting the volume below elevation 9.8 feet and adding it at elevation 10 feet. The routing was also complicated by a second railroad that runs parallel to and east of Fourmile Creek. The embankment is about 200 feet east of Fourmile Creek with a crest elevation above 14.7 feet. Since this prevents Fourmile Creek from rapidly flooding the area east of the railroad, the volume was excluded from the routing below elevation 14 feet and added at elevation 14.7 feet. The elevation-outflow data from HEC-RAS was combined with the area data to produce the elevation-area-outflow table used in the model (table A-27).

Table A-27 Elevation-Area data for Fourmile Creek

Elevation Feet	Existing Area Acres	Existing Outflow cubic ft per sec
0	0	0
1.9	4	550
2.0	5	600
7	6	2,150
8	10	2,850
9.8	20	4,280
10	274	4,450
12	413	6,550
14.1	470	9,130
14.7	776	10,400
16	770	11,000

4.2 Fourmile Creek HEC-HMS Storage Results

The computed peak outflow and stage for the .01, .004, and .002 exceedance probabilities were used to evaluate the existing case with storage (12A). The peak inflow and stage was for the same events were used to evaluate 11B since it represents the case without storage.

No reduction was made to discharges for .50, through .04 exceedance probabilities since for the most part these discharges remained within stream banks. HEC-HMS runs were made for exceedance probabilities of .04, .02, .01, and .002 and are summarized in table A-28. The initial loss varied from 1.6 to 3.2 defending upon the exceedance probability of the storm and agreed with earlier HEC-HMS for Easton Avenue. The discharge frequency tables show the reduction in peak discharge due to the storage. Computations started with inflow equal to outflow. The results were used in HEC-FDA to determine the performance of the Red Rock Remedial Levee. Stages were rounded to nearest tenth foot.

Table A-28 Reduction in Peak Discharge due to Storage on Fourmile Creek

Storm Exceedance Probability	11B Peak stage without storage Feet	11B Peak Discharge without storage CFS	12A Peak stage with storage Feet	12A Peak Discharge with storage CFS
.1	10.9	5,430	no change	no change
.04	n/a	6,890	11.5	6,050
.02	13.2	8,010	12.3	6,900
.01	14.1	9,120	13.0	7,740
.002	15.6	11,700	14.4	9,860

The peak discharges without-storage and with-storage from table A-28 were used to create a flow transform for inflow and outflow used in FDA. This transform was used to evaluate the influence of storage on performance of the Red Rock Remedial levee.

IV. HYDRAULICS

1. Water Surface Profile Models and Datum

Water surface profiles were developed using HEC-RAS Version 3.0.1 (reference 18). Eight profiles were computed from each model and used in the Flood Damage Analysis program (HEC-FDA is discussed in later sections of this appendix). The exceedance probabilities for these events were .50, .20, .10, .04, .02, .01, .004, and .002.

The HEC-RAS flood profiles were also used to produce inundation mapping with MicroStation (reference 19). Topographic mapping with a 2-foot contour interval was developed from aerial photographs taken in 1996 and 1997. Aerial Services Incorporated under contract with the Corps of Engineers Rock Island converted the 1997 photographs to digital topographic mapping in 2001. Topographic mapping based upon the 1996 photographs was produced by Western Air and was furnished to the Corps by the City. Profiles for exceedance probabilities of .10, .02, .01, and .002 were used to produce the inundation maps.

Hydraulic model cross sections were surveyed for the Des Moines River, Raccoon River, Fourmile Creek, and Walnut Creek by the City during 2000 and 2001. Channel elevations of the Des Moines and Raccoon Rivers were obtained by hydrographic survey. Over-bank elevations were obtained employing either a global positioning system or traditional surveying methods, and in some cases, this data was augmented with the 1996 topographic mapping. All data was geo-referenced and the models were built with the cross sections looking downstream. The HEC-RAS models for the Des Moines River, Fourmile Creek, and Walnut Creek were modeled in both Des Moines City Datum and NGVD. The Raccoon River was modeled in NGVD only. The Des Moines zero City Datum

is 773.84 feet NGVD. Bridge data were furnished by the City, the State of Iowa Department of Transportation, and the Corps of Engineers Survey Branch. It was supplemented with field observations and photographs.

1.1 HEC-RAS Model Development

The Des Moines River model begins at about 1,000 feet downstream of its confluence with Fourmile Creek, and extends just upstream of the Interstate 80 Bridge. The model was prepared from 53 surveyed cross sections. The Des Moines River modeling and mapping was completed in December 2002.

The Raccoon River model begins at its confluence with the Des Moines River and extends just upstream of the West 63rd Street Bridge. It was prepared from 32 surveyed cross sections. The Raccoon River modeling and mapping was completed in February of 2003.

The Fourmile Creek model begins at its confluence with the Des Moines River and extends upstream about 6,800 feet upstream of the East Douglas Avenue Bridge. The model was prepared from 34 surveyed cross sections. The Fourmile Creek modeling and mapping was completed in March 2003.

The Walnut Creek model begins at its confluence with the Raccoon River and extends upstream to the downstream side of the Interstate 235 Bridge. It was prepared from 26 surveyed cross sections. The Walnut Creek modeling and mapping was completed in February of 2002.

Generally, contraction coefficients of 0.1 and expansion coefficients of 0.3 were used between cross-sections. However, these coefficients were increased at bridges where abrupt changes in cross section took place. The range of Manning's roughness n-values appears in the following table A-29.

Table A-29 Summary of HEC-RAS Models

	Stream			
Feature	**Des Moines**	**Raccoon**	**Fourmile**	**Walnut**
Stream length	79,000 feet	45,000 feet	43,637 feet	16,600 feet
Number of cross sections	142	83	85	42
Number of bridges	20	13	12	5
Channel "n"-value	.020-.035	.022-.030	.038-.0475	.032-.035
Overbank "n"-value	.020-.135	.060-.130	.040-.140	.068-.137

Des Moines River model had a starting energy grade slope of .0004 feet per feet. The starting level considered full flood control pool conditions downstream at Red Rock and also used engineering judgment. The model starting conditions did not influence water levels in Des Moines. Models for Fourmile Creek and Walnut Creek used the normal depth option. The Raccoon River model used starting water levels for concurrent events from the junction point of the Des Moines River model.

1.2 HEC-RAS Calibration and Verification

The Des Moines River model was calibrated using observed water levels from the 1993 flood and from the USGS gage at S. E. Sixth Street (05485500) Rating #17. The Raccoon River model was calibrated using observed water levels from the 1993 flood. Discharges were estimated based upon

water levels. Fourmile Creek was verified by comparing computed elevations at Easton Avenue to USGS 05485640 rating curve. Locations used to adjust the discharges on Fourmile Creek appear in table A-30. Walnut Creek water surface profile verification was based upon engineering judgment.

Table A-30 Fourmile Creek locations for Changing Discharge

Location	HEC-RAS sections	.01 EP* CFS
Hubbell Avenue	43637 to 32055	8,180
Easton Blvd	31236 to 23376	8,290
University Avenue	23100 to 18793	8,400
Scott Street	17471 to 10898	8,850
Railroad 4,500 ft downstream of Scott Street (at mouth)	10861 to 609	7,740
* EP Exceedance Probability		

2. Computed Water Surface Profiles

Water surface profiles for the Des Moines River, Raccoon River, Walnut Creek, and Fourmile Creek are shown on plates A-4 through A-8, in Volume 3. Leetown Creekway from mouth to Scott was completed in 2003. Not all exceedance probabilities were plotted.

3. Inundation Maps

Inundation mapping for the Des Moines River, Raccoon River, Walnut Creek, and Fourmile Creek have been produced in Microstation J format and provided to the City for integration into the City Geographic Information System (GIS).

V. FLOOD DAMAGE ANALYSIS

Risk based analysis is required for all flood damage reduction studies (reference 20). The procedure incorporates the uncertainty of discharge-probabilities, stage-probabilities, and damage. The evaluation of alternatives used HEC-FDA, a flood damage analysis program (version 1.2 see reference 21). The program results are displayed first followed by detailed descriptions of the data and the assumptions used in the program.

1. FDA Results for H&H Performance

Corps of Engineer guidance directs that flood risk for levees be described using expected annual stage exceedance probability, long-term risk, and conditional probability of non-exceedance instead of freeboard (reference 22). The statistics are described in the next paragraph and values for alternatives appear in tables A-31 and A-32. The performance values are summarized by damage center. The alternatives are defined in the main report and recommended alternatives are discussed in the Economic Appendix.

The exceedance probability is the probability that a specific event will occur in any given year. For example, the .01-exceedance probability event has a 1 percent chance of occurring in any given year. When there is no existing levee, the target stage for the without-project condition is associated with the start of significant damage. This situation occurs only at Walnut Creek. For

levees and floodwalls, the top of the project is used for the target stage. This is the case for the remaining damage centers.

The median and expected annual exceedance probabilities are values associated with the target stage. The median exceedance probability is the middle value in an ordered list (thus, there is a .5 probability that the actual value is less than the value). The expected exceedance probability is the mean or average value. For normal probability density functions, the expected and median are the same. "Because probabilities must be inferred from random sample data, they are uncertain and mathematical expectation cannot be computed exactly as errors due to uncertainty do not necessarily compensate. For example, if the estimate based on sample data is that a certain flood magnitude will be exceeded on the average once in 100 years, it is possible that the true exceedance could be three times per hundred years, but it can never go less than zero times per hundred years. The impact of errors in one direction due to uncertainty can be quite different from the impact of errors in the other direction. Thus, it is not adequate to simply be too high half the time and too low the other half (reference 3 page 11-1)." The expected probability correction is computed and applied to address this irregularity.

The long-term risk lists the probability of the target stage being exceeded in a 10-year, 25-year, and 50-year period.

The conditional non-exceedance probability by events lists the chance of containing the specific .10, .04, .02, .01, .004 and .002-exceedance probability within the target stage, should that exceedance probability event occur. Since the alternatives involve levees, this number gives the probability of the levee containing the specific exceedance probability in accordance with the uncertainty values supplied for discharge and stage.

Table A-31 Hydrologic and Hydraulic Performance Summary

ID #	Stream	Levee Description	Index Stage	See Note 1		Long Term Risk			Conditional Non-Exceedance Probability by Event					
				Median	Expected	10-yr	25-yr	50-yr	.10	.04	.02	.01	.004	.002
1A	D. M.	exist Birdland	levee	.28	.28	.96	.99	1.00	.61	.53	.38	.17	.02	.00
1B	D. M.	raise Birdland	32	.002	.003	.02	.07	.13	1.00	1.00	.99	.98	.77	.44
1C	D. M.	raise Birdland	33.5	.001	.002	.01	.04	.09	1.00	1.00	.99	.99	.89	.65
1D	D. M.	raise Birdland	36	.001	.000	.002	.006	.01	1.00	1.00	1.00	1.00	.99	.99
2A	D. M.	exist Central Pl	Levee	.14	.15	.80	.98	.99	.72	.34	.11	.02	.00	.00
2B	D. M.	raise Central Pl	32.6	.001	.002	.01	.04	.08	1.00	1.00	.99	.99	.89	.66
2C	D. M.	raise Central Pl	33.5	.001	.001	.009	.02	.04	1.00	1.00	1.00	.99	.96	.86
2D	D. M.	raise Central Pl	34.2	.001	.000	.002	.006	.01	1.00	1.00	1.00	.99	.99	.97
3A	D. M.	exist East (DM)	Levee	.001	.001	.01	.02	.05	1.00	1.00	1.00	.99	.94	.82
5A	D. M.	exist South (DM)	Levee	.001	.001	.01	.02	.05	1.00	1.00	1.00	.99	.94	.82
"	R. R	South (RR)	Levee	.001	.001	.01	.02	.05	1.00	1.00	1.00	.99	.94	.81
4A	D. M.	exist West (DM)	Levee	.001	.001	.00	.01	.02	1.00	1.00	.99	.98	.87	.69
"	R. R.	West (RR)	Levee	.001	.001	.01	.02	.05	1.00	1.00	1.00	.99	.94	.80
6A	R. R.	exist Sect 205	Levee	.002	.003	.02	.06	.13	1.00	1.00	.99	.98	.77	.43
7A	R. R.	exist Water Works	Levee	.001	.000	.004	.01	.02	1.00	1.00	1.00	.99	.98	.93
8A	R. R.	exist W Des Moines	Levee	.001	.002	.01	.04	.09	1.00	1.00	.99	.99	.88	.65
9A	Walnut	no levee Grand Ave	818.34	.046	.052	.41	.73	.92	.91	.42	.16	.05	.01	.00
9B	Walnut	levee Grand Ave	824.50	.002	.003	.03	.08	.16	1.00	.99	.98	.91	.73	.57
9C	Walnut	levee Grand Ave	825.50	.001	.002	.01	.04	.09	1.00	.99	.99	.96	.88	.80

Note 1 Target Stage Annual Exceedance Probability

Note 2 Depending upon the absolute value the performance numbers were truncated to two or three decimal places.

Note 3 These Conditional Non-Exceedance probabilities do not consider closure structures.

Table A-32 Hydrologic and Hydraulic Performance Summary (Continued)

Alt. or Option	Stream	Levee Name	Index Stage	See Note 1		Long Term Risk			Conditional Non-Exceedance Probability by Event					
				Median	Expected	10-yr	25-yr	50-yr	.10	.04	.02	.01	.004	.002
11B	FMCr LCr	Leetown levee (proposed)	790.25	.001	.002	.01	.04	.09	1.00	.99	.98	.95	.87	.80
12A	FMCr LCr	Red Rock Remedial (existing)	789.50	.001	.001	.01	.03	.06	1.00	.99	.99	.97	.91	.86

Note 1 Target Stage Annual Exceedance Probability
Note 2 Depending upon the absolute value the performance numbers were truncated to two or three decimal places

2. Exceedance Probability Relationships Used in HEC-FDA

The discharge frequency data for Fourmile Creek, Walnut Creek and the Raccoon River were generated using the analytical method within HEC-FDA (reference 21). For the most part, the generated values were identical or near identical to the adopted discharges discussed earlier in this report.

Creating discharges for the Des Moines River was complex because Saylorville Reservoir (drainage area 5,823 square miles) reduces the peak discharges downstream of the dam (within the City). The discharge-frequency curve was produced in two steps. First, the program was given information to generate an exceedance probability relationship for the unregulated condition. Next, a flow transfer relationship was added to the discharge-frequency function to adjust the unregulated discharges to regulated discharges. In other words, the transfer simulated the existing reservoir.

2.1 Des Moines River at 2nd Avenue

The 2nd Avenue relationship was used for locations on the Des Moines River upstream of the confluence of the Raccoon River. The drainage area above Saylorville Reservoir is 5,823 square miles. The drainage area at 2nd Avenue is 6,245 square miles, so the difference in areas is 422 square miles, with 372 square miles contributed by Beaver Creek (reference 23). Since there is no gage with a significant period of record at this location, the discharge-frequency was estimated using reference 2. A mean log, a standard deviation, a skew, and a record length were used with the analytical method to generate the unregulated discharge-frequency curve. Discharge values from the regulated discharge-frequency curve (also from reference 2) were then used in a transfer relationship.

The mean log of 4.209 for the unregulated case was computed using a regression equation (see reference 2 section 4.3 page 22). The mean log was computed from a formula using drainage area (M=.000052xDA+3.8840). The other parameters were set equal to values for inflow into Saylorville Reservoir (reference 2 table 4.8, page 25). These parameters included a standard deviation of 0.271, a skew of –0.2, and an equivalent record length of 78 years. The computed data appear in table A-33. The unregulated discharge-frequency values were taken directly from reference 2 or interpolated from a discharge-frequency plot, and appear in table A-33. The transform table consisted of the pairs of unregulated and regulated discharges for the same exceedance probabilities and appears in table A-33.

Table A-33 FDA Discharge Frequency Data for 2nd Avenue

Exceedance Probability	Unregulated Without Dam CFS	Regulated With Dam CFS
0.999	1,967	1,967
0.700	11,849	11,849
0.500	16,520	14,000
0.300	22,722	16,300
0.200	27,499	18,000
0.100	35,480	19,000
0.040	46,161	25,000
0.020	54,462	30,000
0.010	63,001	37,000
0.004	74,668	45,000
0.002	83,859	52,000
0.001	93,311	60,000

For the 0.01-exceedance probability event with the regulated case the instantaneous peak was 1.009 times higher than the 1-day duration discharge (also regulated). Because this change is so minor, no attempt was made to adjust unregulated discharges from 1-day duration obtained using reference 2 to instantaneous peaks.

With a confidence limit of 5 percent, the largest discharge for the .001-exceedance probability generated by HEC-FDA is 125,353 cfs. To extend the transform function to this largest possible discharge, it was assumed that for an unregulated discharge of 126,000 cfs, the regulated discharge would also be 126,000 cfs. In other words, for massive floods, Saylorville Dam would not reduce the peak discharge.

2.2 Des Moines River at Southeast 14th Street

The Southeast 14th Street relationship was used for locations on the Des Moines River that were downstream of the confluence of the Raccoon River. The relationship was constructed in the same manner as 2nd Avenue. The unregulated discharges were estimated by adjusting 1-day duration discharges into instantaneous peak discharges. Then a flow transfer relationship was used to relate unregulated and regulated discharges. The regulated discharges for instantaneous peaks used in this transform came directly from reference 2.

Since discharges for instantaneous peaks for the unregulated case did not exist, they were estimated. The instantaneous peak discharges were determined by multiplying the 1-day duration data by 1.077 (p. 48 reference 2). This factor for the unregulated case was determined using discharges from the regulated case. The discharges for both 1-day duration and instantaneous were published for the regulated case as were the instantaneous peak discharges (reference 2). The 1-day duration discharges were found in table 5.15 of reference 2.

The unregulated instantaneous peak discharges for probabilities of 0.50, 0.10, and 0.01 were used with a period of 80 years to generate log Pearson III statistics for the unregulated condition. The relevant statistics are: a mean 4.4316, a standard deviation of .2478, and a skew of -0.1707. Discharges generated by this method appear in table A-34. The statistics compared well to the statistics for the 1-day duration condition. The transform table consisted of pairs of unregulated and regulated discharges for the same exceedance probability and can also bee seen in table A-34.

Table A-34 FDA Discharge Frequency data for Southeast 14th Street

Exceedance Probability	Unregulated Without Dam CFS	Regulated With Dam CFS
0.9990	3,731	3,731
0.7000	20,041	20,041
0.5000	27,474	25,000
0.3000	37,317	31,000
0.2000	44,711	35,000
0.1000	57,133	40,000
0.0400	73,689	58,000
0.0200	86,527	72,000
0.0100	99,723	87,000
0.0040	117,756	110,000
0.0020	131,958	131,958
0.0010	146,581	146,581

With a confidence limit of 5 percent, the largest possible discharge for the .001-exceedance probability generated by HEC-FDA is 193,967 cfs. To extend the transform function to this discharge, it was assumed that at an unregulated discharge of 194,000 cfs, the regulated discharge would also be 194,000 cfs.

3. Other HEC-FDA Data Organized by Levee System

3.1 Uncertainty of Stage

The uncertainty of the stage-discharge relationship was determined from data at the 2nd Avenue gage. The standard deviation of error in stage at this location is computed to be 0.55 feet however 0.65 was used for all HEC-FDA computations on the Des Moines River and the Raccoon River. The larger value was selected based on experience and results in a more conservative analysis. Equation 5-3 is described in paragraph 5-3 of reference 20 (EM 1110-2-1619) and summarized as follows. The standard deviation was computed using 12 observed flow measurements between 43,200 cfs and 12,600 cfs in the equation, $S=\{\text{sum of } (X-M)^2/(n-1)\}^{1/2}$, X is the observed stage, M is the stage using the rating curve, and n is the number of observations.

The remaining portions of this section are organized by levee system. Birdland Park and Central Place are listed separately but the downtown levees are grouped together. The existing levees on the Raccoon River are also grouped together.

3.2 Birdland Park Levee System (Alternatives 1A, 1B, 1C, 1D and 1E)

The existing levee (1A) was evaluated along with three alternatives (1B, 1C, and 1D) to raise the levee. The levee starts at Saylor Road (RAS section 52540) and extends upstream about two miles. The HEC-FDA analysis of Birdland used an index station just upstream of 2nd Avenue (RAS section 54230). The index station is a representative location used as a reference point in the analysis. Case 1E evaluated the closure and is also discussed in this section.

3.2.1 Exceedance Probability Functions with Uncertainty

All plans were evaluated using the 2nd Avenue exceedance probability function.

3.2.2 Stage Damage Function with Uncertainty

The stage-discharge profiles start at RAS section 50835 and end at section 59275. The structural inventory data (SID) module used eight profiles from HEC-RAS. This feature correlates each property to the appropriate river mile and computes composite stage damage relationships. Some revisions were made to the computed water surface elevations used in the model since profiles for the SID module must increase with increasing station number. If the water surface elevation dropped, it was replaced with the elevation from the previous station. Two values were adjusted—one was increased .002 feet the other 0.1 feet. The profiles used in HEC-FDA appear in table A-35.

Table A-35 Profiles for Birdland SID Module

RAS Station	Bottom Elevation	Exceedance Probability							
		.5	.2	.1	.04	.02	.01	.004	.002
50835	777.03	791.77	792.97	793.25	795.3	797.11	799.26	802.3	805.66
52540	779.24	792.34	793.61	793.92	795.95	797.72	799.91	802.9	806.18
53930	779.35	792.76	794.06	794.37	796.39	798.12	800.18	803.07	806.28
54004	779.8	792.8	794.11	794.42	796.45	798.19	800.25	803.14	806.33
54078	779.8	792.82	794.14	794.45	796.48	798.22	800.29	803.18	806.41
54230	780.82	792.84	794.16	794.47	796.51	798.25	800.33	803.22	806.46
55315	776.17	793.07	794.39	794.7	796.68	798.36	800.38	803.22	806.46
55569	779.74	793.15	794.5	794.82	796.84	798.57	800.67	803.52	806.7
55651	779.74	793.29	794.65	794.97	796.97	798.69	800.79	803.62	806.78
55795	773.95	793.53	794.88	795.19	797.17	798.85	800.93	803.73	806.85
59275	780.49	794.47	795.93	796.27	798.33	800.03	802.15	804.9	807.83

The stage discharge function for the HEC-FDA index station (RAS section 54230) is repeated in table A-36. The stage for a discharge of 60,000 cfs (.001 exceedance probability) was computed using HEC-RAS by extending the levees vertically upward. This probably overestimates the water surface elevation. The FDA model requires a stage for the largest possible discharge the program can generate. At 2nd Avenue, this is about 126,000 cfs. The water surface elevation for a discharge of 126,000 was estimated by adding ½- foot to the stage computed for the 60,000 cfs discharge instead of using RAS, the rationale being that the levee would fail and the water level would not increase significantly.

Table A-36 Stage Discharge Function for Birdland Index Station

Discharge	Stage	Std dev error
0	780.82	0
14000	792.84	0.65
18000	794.16	0.65
19000	794.47	0.65
25000	796.51	0.65
30000	798.25	0.65
37000	800.33	0.65
45000	803.22	0.65
52000	806.46	0.65
60000	808.75	0.65
126000	809.25	0.65

3.2.3 Levee Features

The existing levee was assumed to fail before the exterior water level reached the levee crest. The relationship for the probability of failure referenced to the index station is shown in table A-37. For a discussion of the data in table A-37 see Appendix C Geo-technical .Stanley Consultants.

Table A-37 Geotechnical Failure Data for Existing Birdland Levee

River Stage at description point City (NGVD) Ft.	Probability of Failure	Description of Elevation	River Stage at Index section NGVD Feet
10 (783.8)	0.00	Landside grade 185+00 to 200+00	784
24 (797.8)	.95	Landside toe 248+00	798
27 (800.8)	.99	Landside ground level at landside toe of levee	801
32.2 (806)	1.00	Top elevation of existing levee 243+87	806

Alternatives 1B, 1C, and 1D used crest elevations of 806.1, 807.7, and 810.15 feet NGVD respectively at the index station. Since these proposed alternatives would meet Federal standards, they were assumed to fail when the exterior water level reached the levee crest.

3.2.4 Saylor Road Closure Analysis (Alternative 1E)

The Saylor Road RAS section (52540) is downstream of the index station. If the closure fails (Case 1E) the interior water level becomes a flat profile equal to that of RAS section 52540. Such a profile was used with the structural inventory distribution to create damage curves. The relation between the exterior water level and the interior water level is the relationship between RAS section 54230 and section 52540 respectively. Above the levee crest elevation (804.5), the exterior and interior elevations are set equal. The relationship between exterior and interior water levels in table A-38 was used for both existing and proposed closures.

Table A-38 Exterior and Interior Water Levels at Saylor Road Closure

Location	Water Surface Elevation in Feet NGVD								
Exterior	792.84	794.16	794.47	796.51	798.25	800.33	803.22	804.5	809.25
Interior	792.34	793.61	793.92	795.95	797.72	799.91	802.9	804.5	809.25

Existing Closure

The crest of Saylor road is elevation 799.84 feet (26 feet City Datum). The crest will be raised to elevation 802.84 with a sandbag closure three feet high. Data in table A-39 was adjusted to the index station and used to evaluate the existing closure. An adjustment of 0.2 feet was added to the Saylor Road Crest and to the top of the sandbag to adjust for the difference between Saylor Road and the Index station. RAS changes increased the adjustment to 0.35 feet but the difference was slight and the analysis was not redone.

Table A-39 Geotechnical Failure Data for Sandbag Closure at Saylor Rd.

Exterior Stage (Ft.)	Probability Of failure	Adjusted Elev. (Ft.)
799.84	0.00	800.04
802.83	0.99	803.03

The proposed alternative used a crest at 804.5 to simulate the top of gate. Elevation 804.5 is not the adjacent levee crest; it is the elevation at the index station where the existing levee is assumed to fail. No adjustment was made to elevation 804.5, since it was already adjusted. The difference between estimates of equivalent annual damage was the benefit of replacing the sandbag closure with a gate. The approach used to study closures is in agreement with concepts in reference 24.

3.3 Central Place Levee System (Alternatives 2A, 2B, 2C and 2D)

This levee starts near University Street Bridge (RAS section 52540) and extends just upstream of the 2nd Avenue bridge. The existing levee (2A) and three alternatives (2B, 2C, and 2D) were evaluated. The index station for Central Place is along a line connecting College Avenue (west side) with Washington Avenue (east side) at RAS section 50835. The profile used for Central Place extends from RAS sections 44945 to 55315. (Although the cross-section numbers were revised after the HEC-FDA runs had been completed, the water levels did not change.)

3.3.1 Exceedance Probability Functions with Uncertainty

All plans were evaluated using the 2nd Avenue exceedance probability function.

3.3.2 Stage Damage Function with Uncertainty

The structural inventory data (SID) module used eight profiles from HEC-RAS. However, some revisions were made to the computed water surface elevations since profiles for the SID module must increase with increasing station number. If the water surface elevation dropped, it was replaced with the elevation from the previous station. The profiles used at Central Place appear in table A-40

Table A-40 Profiles for Central Place SID module

RAS Station	Bottom Elevation	Exceedance Probability							
		.5	.2	.1	.04	.02	.01	.004	.002
45990	778.70	790.86	791.84	792.09	794.07	795.92	798.07	801.28	804.88
46155	780.12	790.87	791.86	792.11	794.08	795.93	798.07	801.28	804.88
46735	779.02	790.90	791.89	792.14	794.09	795.94	798.07	801.28	804.88
47725	776.44	791.00	792.01	792.26	794.22	796.06	798.17	801.34	804.89
47913	775.70	791.04	792.08	792.34	794.34	496.19	798.34	801.52	805.08
47995	775.70	791.07	492.13	792.40	794.41	796.25	798.41	801.59	805.15
48155	778.43	791.07	792.13	792.40	794.41	796.25	798.41	801.59	805.15
50835	777.03	791.77	792.97	793.25	795.30	797.11	799.26	802.30	805.66
52540	779.24	792.34	793.61	793.92	795.95	797.72	799.91	802.90	806.18
53930	779.35	792.76	794.06	794.37	796.39	798.12	800.18	803.07	806.28
54004	779.8	792.8	794.11	794.42	796.45	798.19	800.25	803.14	806.33
54078	779.8	792.82	794.14	794.45	796.48	798.22	800.29	803.18	806.41
54230	780.82	792.84	794.16	794.47	796.51	798.25	800.33	803.22	806.46
55315	776.17	793.07	794.39	794.7	796.68	798.36	800.38	803.22	806.46

The stage discharge function for the index station (RAS section 54834) appears on table A-41. The stage for the .001-exceedance probability (60,000 cfs) computed by HEC-RAS assumes the levees always confine the discharge and overestimates the water surface elevation for large floods. HEC-FDA requires a stage for the largest possible discharge generated by the program. At 2nd Avenue, this discharge is about 126,000 cfs. The water surface elevation for a discharge of 126,000 was estimated by adding ½- foot to the stage computed for the 60,000 cfs.

Table A-41 Stage Discharge Function for Central Place Index Station

Discharge	Stage	Std dev error
0	777.03	0
14000	791.77	0.65
18000	792.97	0.65
19000	793.25	0.65
25000	795.30	0.65
30000	797.11	0.65
37000	799.26	0.65
45000	802.30	0.65
52000	805.66	0.65
60000	807.85	0.65
126000	808.35	0.65

3.3.3 Levee Features

As can be seen from the failure information in table A-42, the existing levee has a good chance of failing before the water level reaches the crest.

Table A-42 Geotechnical Failure Data for Existing Central Place Levee

River Stage at section 48155 City (NGVD) Ft.	Probability of Failure	Description of Elevation	River Stage at section 50835 NGVD Feet
1 (775)	0.00	Sewer invert changed to min. channel el.	777.03
18 (792)	.10	Riverside ground level	792.70
22 (796)	.95	Landside ground level at landside toe of levee	796.85
25 (799)	.99	Average base elevation of existing levee	799.85
32 (806)	1.00	Top elevation of existing levee	806.51

HEC-FDA used the data at the index station (RAS section 50835). This was generated by transferring data provided by ED-G (28 May 2002) for station 48155 to the index station. Alternatives 2B, 2C, and 2D used crest elevations of 806.9, 807.9, and 808.7 feet NGVD respectively at the index station; failure for these options occurred only when water reached the levee crest.

3.4 Federal Downtown Levee Systems (Alternatives 3A, 4A, 5A, 3E, 4E, and 5E)

3.4.1 Description of East, South, and West Levees

There are three existing Federal levees that reduce flood damages downtown: East (3A), South (5A) and West (4A). The systems are described in Appendix C, Volume 3, Plates and Drawings. In past flood insurance studies the landward areas are labeled zone X (areas protected by levees from the 100-year flood). The East Levee is along the Des Moines River while the West and South Levees are along both the Des Moines and Raccoon Rivers.

The East Levee starts 250 feet upstream of the I-235 Bridge (bridge is RAS section 45984) and runs downstream along the left bank (looking downstream) of the Des Moines River to near the mouth of Fourmile Creek.

The West Levee starts at Center Street Dam (RAS section 44214) and extends downstream along the right bank of the Des Moines River to the junction of the Raccoon River (RAS section 39916). The levee then runs upstream on the left bank (looking downstream) of the Raccoon River. The levee tie off is about 1,000 feet upstream of Fleur Drive Bridge (Raccoon River).

On the Raccoon River, the upstream most point of the South Levee is downstream of SW 7th Street Bridge. The levee runs downstream on the right bank of the Raccoon until it reaches the Des Moines River. The levee then runs downstream along the right bank of the Des Moines River. The downstream most point on the Des Moines River is 1,600 feet downstream of SE 14th Street Bridge (near RAS section 35110).

3.4.2 Exceedance Probability Functions with Uncertainty

The exceedance probability functions used in HEC-FDA are identified in table A-43 for each levees system.

Table A-43 Exceedance Probability Functions used to Evaluate Downtown Levees

Levee System	Functions Des Moines River	Functions Raccoon River
East	SE 14th St (page 24)	does not apply
South	SE 14th St (page 24)	Fleur Drive (page 2)
West	2nd Ave (page 23)	Fleur Drive (page 2)

3.4.3 Stage Discharge Functions with Uncertainty

A preliminary examination of the levees indicated that Federal justification for raising them was unlikely. For this reason, several steps were taken to reduce the cost of the analysis. Instead of computing the reach stage-damage function using profiles to create SID data, the Economics Branch created a composite stage-damage relationship with uncertainty for each levee system. HEC-FDA used this relationship to compute equivalent annual damage. This eliminated the cost of identifying and correlating each structure to a river mile.

As with all the other HEC-FDA analyses, a stage-discharge relationship was specified for each index station. The standard deviation of error for all stage-discharge relationships was 0.65 feet. (Although the cross-section numbers were revised after the HEC-FDA runs had been completed, the water levels did not change.) The levee systems were evaluated using the Des Moines River stationing from the May 2002 HEC-RAS model. The Des Moines River index station used for both the East and South Levees was 320 feet downstream of Southeast 6th Street Bridge (Des Moines RAS section 37337). The Des Moines River index station used for the West levee was 200 feet downstream of the Walnut Bridge (Des Moines RAS section 42567). The South and West Levees were also evaluated using an October 2002 HEC-RAS model of the Raccoon. The index station for the South Levee was 130 feet downstream of Southwest 3rd Street (Raccoon RAS section 1228). The index station for the West Levee was 180 feet upstream of Southwest 7th Street (Raccoon RAS section 3339). Stage Discharge relationships on the Des Moines River appear in table A-44; similar relationships on the Raccoon River appear in table A-45.

Table A-44 Stage Discharge Functions at Des Moines River Index Stations

Des Moines Discharge (CFS)	4 West Index Stage (Ft)	Des Moines Discharge (CFS)	3&5 (E&S) Index Stage (Ft)
0	772.78	0	767.28
14,000	786.28	25,000	785.48
18,000	789.19	35,000	788.29
19,000	790.24	40,000	789.25
25,000	793.18	58,000	791.85
30,000	795.15	72,000	793.52
37,000	797.34	87,000	794.96
45,000	800.82	110,000	796.92
52,000	803.26	132,000	798.14
52,050	803.29	145,000	799.30
126,000	804.79	200,000	800.10

Table A-45 Stage Discharge Functions at Raccoon River Index Stations

Raccoon Discharge (CFS)	4 West Index Stage (Ft)		Raccoon Discharge (CFS)	5 South Index Stage (Ft)
0	772.64		0	772.48
14,420	787.02		14,420	786.37
24,452	790.11		24,452	789.36
32,400	791.55		32,400	790.56
43,005	794.40		43,005	793.42
51,900	796.37		51,900	795.36
61,300	798.44		61,300	797.39
74,831	801.22		74,831	800.08
85,900	803.51		85,900	802.22
94,000	804.65		94,500	803.55
134,000	805.10		134,000	804.05

With the exception of the two largest discharges in each table, stages were computed using HEC-RAS. The last or largest discharge for each index station equals the largest possible discharge that the FDA model can generate. At all index stations, this discharge will cause the levee to fail at the index station. The elevation for this mammoth discharge was estimated by making it 0.5 feet higher than the levee crest elevation at the index station. The HEC-RAS models created for this study cannot be used for this situation because the model was built assuming that the water is confined between the levees. The next to the last entry was estimated from a HEC-RAS rating curve. It represents the discharge and stage equal to the elevation of the adjusted levee crest. Once the water exceeds this elevation the levee would fail.

3.4.4 Levee Features

The analysis of each Federal levee was based on the assumptions that the levee failed when water overtopped the crest of the levee. A second assumption was that after failure the interior water level equaled the exterior water level (of the river). The location of overtop was determined by comparing a series of lines drawn parallel to the .002 exceedance probability profile with the design levee crest from as-built drawings (for drawings ,see reference 25). The elevation of the first overtop was then transferred to the index location by using a line parallel to the .002 exceedance probability profile. Adopted crest values appear in table A-46.

Table A-46 Adopted Overtop Crest Elevations for Downtown Levees

River	Levee System	Overtop Location	Adjusted Crest at Index (Ft.)
Des Moines	East	Station 145+00 plate DM-I-10	799.34
Des Moines	South	Station 13+50 plate DM-III-5	799.35
Des Moines	West	Station 100+00 plate DM-II-3	803.29
Raccoon	South	Station 15+00 plate DM-III-2	803.55
Raccoon	West	Station 83+00 plate DM-II-8	804.7

East Levee (Alternative 3A)
The overtop location selected for the East Levee is downstream of Southeast 14th Street (Station 145+00 plate DM-I-10 reference 25). The levee crest is about 1.2 feet above the computed water surface at this location. This distance was transferred to the index station to produce an adjusted overtop crest elevation of 799.34 feet. This elevation is slightly lower than the actual levee crest at the index station (elevation 799.6 feet). The East Levee will also overtop upstream of the Locust Street Bridge (Station 41+00 plate DM-I-5 reference 25). However, this second location was not used in the analysis for the following reason:

> The computed water levels near Locust Street are in the range of elevation 804.3 to 804.5 feet. Using these elevations would produce interior water levels greater than three feet above the crest of the East Levee farther downstream. Most of the crest of the East Levee is in the range of elevation 797 to 802 feet. In a more limited manner the same situation is true for the West interior area. However, the range of variation is considerably less for the West Levee system and no adjustment was made.

South Levee (Alternative 5A)
The South Levee crest will first overtop on the Des Moines River at the most downstream portion of the levee (Station 13+50 plate DM-III-5 from reference 25). The levee crest is about 1.2 feet above the water surface at this location. When this distance is transferred to the index station, the adjusted overtop crest computes as elevation 799.35 feet. This elevation is slightly lower than the actual crest at the index station (elevation 799.48 feet). The South Levee crest is overtopped on the Raccoon River from the mouth to 1,200 feet upstream of its mouth (Station 15+00 plate DM-III-2 from reference 25). No adjustment was required and the levee crest (elevation 803.55 feet) at the index station was used for the computations.

West Levee (Alternative 4A)
The West Levee will first overtop on the Des Moines River upstream of Locust Street Bridge (Station 100+00 plate DM-II-3 from reference 25). At this location, the levee crest is 0.31 feet below the water surface profile at this location. When this distance is transferred to the index station the adjusted overtop crest computes as elevation of 803.29. This elevation is slightly lower than the actual crest elevation at the index station (elevation 803.6 feet). The computed water surface profile is generally below the existing levee. The levee is overtopped for a length of 200 feet or about 6 percent of the levee reach along the Des Moines. The South Levee crest appears to overtop on the Raccoon River between 7th St Bridge and the upstream RR Bridge. This is in the region of the index station (Station 83+00 plate DM-II-8 from reference 25) no adjustment was made and the levee crest (elevation 804.7 feet) at the index station was used for the computations.

3.4.5 Analysis of Improved Closure System (Alternative 3E, 4E, and 5E)

Equivalent annual damage was estimated for each without-project closure system and for one with-project (improved) closure system (3E, 4E, and 5E). The data used in the closure analysis was identical to the data used in the levee analysis with one exception—where the levee analysis assumed that the Federal levee failed at the adjusted levee crest; the closure analysis used the geo-technical analysis feature within the levee features option (HEC-FDA) to simulate the probability that the closures would fail between the adjusted sill elevation and the adjusted levee crest elevation. This probability of failure reached the maximum value shown in table A-47 ½ -foot above the elevation of the adjusted sill and remained constant up to the elevation of the adjusted levee crest.

The Engineering Design Branch furnished the combined probability that the closures would be installed and would hold for each levee system. The development of this data through expert solicitation is discussed in Appendix C, Engineering. These values were converted to a probability of levee closure failure (one minus the probability of success equals to the probability of failure). The data should not be mistaken for performance data listed in tables A-31. The data in table A-47 relates to the likelihood of the closure holding or not holding. The probability of closure failure and the closure crest elevation used in the "levee table within FDA" are part of the data used to compute performance by the FDA program (table A-49).

Table A-47 Probability the Downtown Closures will Hold or Fail

Levee System	Probability it Holds Without Project	Probability it Holds With Project		Probability of Failure Without Project	Probability of Failure With Project
East (3)	.28	.81		.72	.19
South (5)	.64	.90		.36	.10
West (4)	.35	.86		.65	.14

The adjusted sill elevation was computed in a manner similar to computing the adjusted levee crest. The actual sill elevation from table A-48 was transferred to the index location. Elevations came from several sources. The closure analysis computed results only for closures on the Des Moines River. The model assumed that after failure the interior water level would equal the exterior water level. Results from the Raccoon River should produce similar results since it is flash flooding on Beaver Creek below Saylorville Dam on the Des Moines that creates the most serious condition.

Table A-48 Sill Closure Elevations on the Des Moines River

City of D. M. Closure Number	Closure (Levee System)	DM Sill City datum Ft.	DM Sill NGVD datum Ft.	COE Sill NGVD Ft.	COE Tiff-file Drawing Number
76	Grand Avenue (WEST)			801.0	
78	Locust Street (WEST)			800.2	
80	Walnut Street (WEST)			800.6	
82	Court Avenue (WEST)				
84	Riverside Drive Panel Closure	23.2	797.04	797.4	Dm060
86	Railroad, 1st south of Court Ave (WEST) (note 1)	27.3	801.14	800.6	Dm087
88	Railroad, 2nd south of Court Ave (WEST) (note 1)	26.5	800.34	800.4	Dm087
19	Opening closed after 1993 (WEST)	removed	removed	removed	Dm062
42	RR SE 1st St and Van Buren (SOUTH) (note 2)	25.2	799.04	799.1	Dm148
72	Grand Avenue (EAST)			801.5	Dm005
75	Locust Street (EAST)			800.5	Dm006
79	Walnut Street (EAST)			801.5	Dm006
81	Court Avenue (EAST)			801.5	Dm006
85	Railroad, 1st south of Court Ave (EAST)	27.3	801.14	801.3 (note 3)	Dm016
87	Railroad, 2nd south of Court Ave (EAST)	26.5	800.34	800.2 (note 4)	Dm017
41	RR SE 1st St and Van Buren (EAST)	25.2	799.04	799.2	Dm038

Note (1) base of rail 0.5 feet higher than top of sill.
(2) base of rail elevation 799.8 feet
(3) Sill at 800.8 feet but base of rail built up.
(4) sill at 799.7 feet but base of rail built up.

Closure Sill Elevations

East (Alternative 3E)
There are two closures, , 41 and 42, on the Des Moines River. Elevation 799.2 feet for the top of the piling of closure number 41 (the City of Des Moines identification number) was used instead of the elevation of the base of the rail (799.7 ft). The levee grade at the closure is elevation 801.5 feet upstream and elevation 801.5 feet NGVD downstream. Elevation 796.94 feet NGVD was used for the adjusted sill elevation at the index station. Note that closure 41 on the left bank is farther downstream than closure 42 on the right bank. Both closures are for the same railroad but different levee systems.

South (Alternative 5E)
Currently roads that cut the levee along the Des Moines River include: Riverside Drive, 1st Street (which becomes Scott), and a railroad (closure 42). The without-project case was evaluated using closure 42. The top of the piling is at elevation 799.1 feet. This elevation was transferred to the index station instead of the elevation of the base of the rail (elevation 799.6 feet). The levee grade at the closure is elevation 802.3 feet upstream and elevation 801.3 feet NGVD downstream. Elevation 796.84 feet NGVD was used for the adjusted sill elevation at the index station. Two additional closures (36 and 38) occur on the Raccoon River but were not evaluated. The with-project condition eliminates closures 42, 36, and 38. The openings will be filled in. Therefore the with-project case used a new sill elevation; the sill elevation of the only remaining closure (1st St). The surface of 1st Street (or Scott) is at elevation 801.8 feet (28 feet city datum). This elevation was transferred to the index station and used for the with-project case (elevation 798.4 feet).

West (Alternative 4E)
There are six closures, 76, 78, 80, 82, 84, 86, and 88, on the Des Moines River near the index station. The sill elevations varied in elevation from 800.2 feet to 801.0 feet. When the sill elevations were transferred to the index station they varied in elevation from 800.95 feet to 801.2 feet. The .004 exceedance probability flood profile was used for transfer sill elevations since it was nearest to the sill elevations. The adjusted sill elevation at the index station (elevation 800.8 feet NGVD) was the average of the transferred values.

Closure Results
The closure analysis was used to compute the economic data for with-out and with-project cases. Computed performance data is shown in table A-49 for the two cases to provide insight on how the sill elevations and the closure reliability (table A-47) relate to performance. The performance difference is non existent to slight, from .10 to .01 exceedance probabilities. This is because most of the water levels generated for these probabilities are below the sill elevations.

Table A-49 FDA Performance Summary for Comparison of Closure Alternatives

Levee	Conditional Non-Exceedance Probability by Event					
Description	.10	.04	.02	.01	.004	.002
Existing East Closures	1.00	1.00	.99	.94	.66	.40
Improved East Closures 3E	1.00	1.00	.99	.98	.87	.71
Existing South Closure	1.00	1.00	.99	.96	.79	.60
Improved South Closure 5E	1.00	1.00	.99	.99	.94	.80
Existing West Closure	1.00	1.00	.99	.93	.63	.36
Improved West Closure 4E	1.00	1.00	.99	.97	.81	.61

3.5 Three Levee Systems on Raccoon River (Alternatives 6A, 7A, and 8A)

Performance values were computed for the levees recently built or modified on the Raccoon River. This analysis was done to describe the levees not to justify raising them. There are no alternatives associated with this work.

3.5.1 Description of Levee Systems

The Raccoon River Section 205 (6A) Levee is described on page 40 of the main report. The levee starts at Southwest 30th Street and runs downstream along the right bank (looking downstream) to Valley Drive. The levee then leaves the river and runs eastward to Fleur Drive.

The Des Moines Water Works Levee (7A) is described in section 4.I of the main report. This ring levee is located on the right bank (looking downstream) of the Raccoon River. The center of the ring levee is about ½- mile upstream of the Fleur Drive Bridge.

The Des Moines-West Des Moines Levee (8A) reduces flood damages from both the Raccoon River and Walnut Creek. The levee is described in section 4.J. of the main report. The portion of the levee on the Raccoon River is along the left bank (looking downstream). It starts at 63rd Street and extends downstream about one half mile before it turns north and runs to Walnut Creek. The levee then extends upstream on Walnut Creek (right bank looking downstream) to above Grand Avenue.

Only performance data for the portion along the Raccoon was calculated. The performance data for the portion of Alternative 8A along Walnut Creek will be identical to that reported for the proposed levee on Walnut Creek near Grand Avenue. This is because both Alternatives 8A and 9B have identical discharge and stage data. And since the old design profile for Des Moines-West Des Moines levee is almost identical to the new Walnut Creek profile, the performance results will also be identical.

3.5.2 Discharge Exceedance Probability Functions with Uncertainty

All three levees were analyzed with the same discharge exceedance probability function called the Fleur Drive function. It is defined in table A-1.

3.5.3 Stage Discharge Functions with Uncertainty

As with the downtown levees, several steps were taken to reduce the cost of the analysis. Instead of computing the reach stage-damage function using profiles to create SID data, the Economics Branch created one stage-damage relationship with uncertainty for each levee system. HEC-FDA needed this relationship in order to compute performance data. A stage-discharge relationship was specified at each index station along with a standard deviation of error in stage of 0.65 feet. While the computed water levels at the HEC-RAS cross-sections seldom changed, the cross-section numbers did. The levee systems were evaluated using the Raccoon River stationing from the October 2002 HEC-RAS model.

The index station used for the Raccoon River Section 205 Levee was located at the overflow location across Fleur Drive (Raccoon RAS section 3 of Fleur Drive Bypass). The index station used for the Des Moines Water Works Levee was located about 2,500 feet upstream of the existing Fleur Drive Bridge (Raccoon RAS section 15577 of Fleur Drive Loop). The index station (Raccoon RAS section 40740) used for the Des Moines-West Des Moines Levee along the

Raccoon River is 2,329 feet downstream of the 63rd St Bridge. The stage discharge relationships for all systems appear in table A-50.

Table A-50 Stage Discharge Functions for Raccoon River Levees

Raccoon River Discharge (CFS)	(6A) Index Stage (Ft)	(7A) Index Stage (Ft)	(8A) Index Stage (Ft)
0	796.81	777.49	791.73
14,420	796.84	791.18	804.78
24,452	798.08	794.73	808.14
32,400	799.60	798.61	809.68
43,005	801.25	799.19	811.30
51,900	802.57	801.23	812.49
61,300	804.19	803.39	813.65
74,831	806.67	806.20	815.58
85,900	808.77	808.45	816.47
94,500	810.84	810.59	817.83
134,000	811.30	811.09	818.30

With the exception of the largest discharges in each table, the stages were computed using HEC-RAS. The last (largest) discharge for the index station equals the largest possible discharge that the FDA model can generate. The water surface elevation for this mammoth discharge was estimated by making it 0.5 feet higher than the elevation of the .002-exceedance event at the index station.

3.5.4 Levee Features

The analysis of each levee assumed that the levee failed when water overtopped the crest of the levee and that the interior water level equaled the exterior water level. The location of overtop was determined by comparing the computed water surface from HEC-RAS with the design levee crest from as-built drawings in reference 25 or crest elevations furnished by the City.

The Raccoon River Section 205 Levee was designed so that water would first overtop it at the most downstream section. Both the overtop location and index station are near Station 63+10 (Plate RR-I-8 of reference 25). The elevation at this point is 808.74 feet NGVD (34.9) and was used as the levee crest at the index station. The majority of the levee is not overtopped until the stage rises higher.

Since the Des Moines Water Works Levee is a ring levee no transfer adjustment was made for the index station. The levee crest data was furnished by the City. The crest elevation varied slightly but did not slope downstream. The lowest elevation was 811.00 feet NGVD; this elevation was used for the elevation of the levee crest at the index station.

The overtop location selected for the Des Moines-West Des Moines Levee is located about 4,000 feet downstream of the 63rd Street Bridge (between stations 116+35 to 119+00 plate WDM-IIIB-5 of reference 25). The levee crest is about 0.7 feet above the computed .002 exceedance probability water surface at this location. When this elevation difference is transferred to the index station, the adjusted overtop crest computes as elevation 817.14 feet. This elevation is lower than the actual levee crest at the index station (elevation 817.84 feet). The overtop elevation was then transferred to the index station by assuming a line parallel to the .002 exceedance probability profile.

3.6 Walnut Creek at Grand Avenue Levee (Alternatives 9A, 9B & 9C)

3.6.1 Description of Proposed Walnut Creek at Grand Avenue Levee

The proposed levee would reduce flood damage on the left bank of Walnut Creek in the vicinity of Grand Avenue. The levee is described on page 46 of the main report. The existing condition without the levee (Alternative 9A) was evaluated along with two proposed levee alternatives (9B and 9C). The proposed levee would start upstream of Grand Avenue and run downstream about one half mile (near Terrace Drive). The HEC-FDA analysis used an index station just upstream of the railroad bridge (Walnut RAS section 11340). The index station is a representative location used as a reference point in the analysis.

3.6.2 Discharge Exceedance Probability Function for Walnut Creek at Grand Avenue Levee

The discharge exceedance probability function used in HEC-FDA was the discharge-frequency relationship for the future condition. The relationship is described in table A-14.

3.6.3 Stage Discharge Functions for Walnut Creek at Grand Avenue Levee with Uncertainty

The HEC-FDA model used eight profiles, a database of structures, and the structural inventory data (SID) module to compute the elevation damage curve. Each property was correlated to the appropriate river station to compute this relationship. The FDA model used profiles between stations WC HEC-RAS 7651 to 12772. Results (in city datum) from the RAS model were converted to NGVD datum by adding 773.837 feet. Since profiles for the SID module must increase with increasing station number the water levels at some stations were changed by a very small amount. If the water surface elevation dropped, it was replaced with the elevation from the downstream station. The FDA model was finished in January of 2002 and used the current RAS model. The HEC-RAS stations were renumbered and the elevations changed slightly in March 2002. The HEC-FDA retained the original stationing numbers but the water surface elevations were updated. The FDA stations, the current RAS stations, and the water surface elevations appear in table A-51

Table A-51 Profiles for Walnut Creek (Grand Ave.) SID module

RAS Station	FDA Station	Bottom Elevation	Exceedance Probability							
			.5	.2	.1	.04	.02	.01	.004	.002
7651	6851	796.9	805.10	808.23	809.56	810.88	911.88	812.98	814.85	816.75
9244	8444	798.3	807.12	809.92	811.35	812.96	814.45	815.34	817.04	818.61
10820	9931	799.7	809.79	812.56	814.21	814.84	815.91	816.44	817.40	818.93
10995	10113	797.5	810.22	813.26	815.09	817.58	818.08	819.67	821.45	822.68
11085	10203	797.5	810.25	813.35	815.26	818.28	818.82	819.73	821.87	823.05
11205	10256	799.7	810.25	813.35	815.26	818.28	818.82	819.73	821.87	822.05
11308	10455	800.6	810.37	813.57	815.57	818.57	819.33	820.37	822.35	823.56
11340	10487	800.6	810.40	813.63	815.67	818.89	819.57	820.56	822.71	824.00
11505	10567	801.2	810.40	813.63	815.67	818.89	819.57	820.56	822.71	824.00
12772	11876	802.7	811.42	814.77	816.73	819.56	820.37	821.50	823.59	824.94

The stage discharge function for the index station (FDA 10487) is repeated in table A-51. The water surface elevation for a discharge 32,524 cfs was computed using HEC-RAS. The water surface elevation for 68,000 cfs was estimated by adding one half foot to the stage computed for

32,524 cfs since the FDA model requires a stage for the largest possible discharge that can be generated by the program. The standard deviation of error in stage varied from .5 feet to 1 foot. This was a larger value than that used for the other rivers because Walnut Creek is a smaller stream and water levels can fluctuate due to downstream bridges. The index station (FDA 10487) was located upstream the railroad bridge (Walnut RAS section 11340) located north of Grand Avenue.

Table A-52 Stage Discharge Function for Walnut Creek at Grand Avenue

Walnut Creek Discharge CFS	(9A) Index Stage Feet	std. dev. of error Feet
0	800.60	0
3000	810.40	.5
5300	813.63	.5
7300	815.76	.7
10600	818.89	.7
13450	719.57	1
17000	720.56	1
22000	822.71	1
27000	824.00	1
32524	825.36	1
68000	826.86	1

3.6.4 Walnut Creek at Grand Avenue Levee Features

Alternative 9A, without any levee, was modeled as the without-project condition. Alternative 9B used a crest elevation of 824.5 feet NGVD at the index station. Alternative 9C used a crest elevation of 825.5 feet NGVD at the index station. Failure for these options occurred at the levee crest.

3.7 Fourmile Creek at Red Rock Remedial Levee (12A) and Proposed Leetown Creekway Levee (Alternative 11B)

3.7.1 Description of Red Rock Remedial Levee and Proposed Levee

The existing Red Rock Remedial Levee (12A) on the Des Moines River has a flank levee that extends up Fourmile Creek to high ground. The levee runs upstream on the right bank of Fourmile Creek until just downstream of the old Norfolk and Southern Railroad Bridge; then it leaves the creek and runs in a northwest direction parallel to the railroad. The levee has a design crest of elevation 789.5 feet (15.66 feet). The HEC-FDA analysis determined the performance characteristics of this levee. This analysis included a reduction in peak discharge due to existing storage upstream of the railroad and west of Fourmile Creek from HEC-HMS modeling.

A proposed alternative (11B) consisted of building a levee west of Fourmile Creek from the railroad bridge upstream to Scott Street. This levee would isolate Leetown Creekway along with the gravel pit; it would also replace a portion of the Red Rock Remedial levee. The height of this levee was varied in HEC-FDA until it contained 95 percent of the .01-exceedance probability events. For purposes of the analysis it was assumed that residents east of Fourmile Creek would insist on a similar levee for their side of the river. Since these levees would eliminate all storage, the HEC-FDA analysis assumed no storage and no reduction in the peak discharges.

3.7.2 Discharge Exceedance Probability Function for Fourmile Creek

'he discharge frequency relationship for 11B, the no-storage case, appears in table A-2. This elationship was simulated in HEC-FDA using the analytical option (Mean of 3.4089, a Standard)eviation of 0.2615, and Skew of -0.2926, and a record length of 35 years). To evaluate ılternative 12A, the HEC-FDA run used the same discharge frequency function as Alternative 1B, but it also included a flow transform to model the storage upstream of the railroad bridge. 'he flow transform for inflow and outflow was taken from data in table A-28.

3.7.3 Stage Discharge Functions for Fourmile Creek

'he index station used in all HEC-FDA runs was located about 10 feet upstream of the railroad ridge. This bridge was discussed earlier and is about 6,000 feet upstream from the mouth of the reek. The location produced a conservative analysis for Alternative 12A since the existing levee s actually downstream of the railroad bridge and would encounter slightly lower water levels. The ıdex station corresponds to Fourmile RAS section 5905. The stage-discharge relationships appear ı table A-53.

'or the most part they are identical and were computed using HEC-RAS. They differ in the stages sed for the largest two discharges. The last (largest) discharge is equal to the largest possible ischarge that the FDA model can generate. The water surface elevation for this mammoth ischarge was estimated by making it 0.5 feet higher than the crest elevation of the existing or roposed levee.

Table A-53 Stage Discharge Function for Red Rock Remedial and Leetown Levees

Fourmile Creek Discharge (CFS)	11B Index Stage (Ft)	12A Index Stage (Ft)
0	774.0	774.0
2640	781.5	781.5
4280	783.6	783.6
5430	784.7	784.7
6540	785.8	785.8
8020	787.0	787.0
9130	787.9	787.9
10,240	788.4	788.4
11,710	789.4	789.4
12,869	789.8	789.45
21,000	790.75	790.0

3.7.4 Levee Features

'he analysis for Alternatives 11B and 12A assumed that each levee failed when water overtopped he crest of the levee and that the interior water level equaled the exterior water level. The overtop levation for the proposed Leetown Levee Alternative (11B) was found by trial and error. A crest levation of 790.25 feet upstream of the railroad bridge contains 95 percent of the .01-exceedance robability events. The overtop elevation for the Red Rock Remedial levee (Alternative 12A) was he design levee crest of elevation 789.5 feet. This flank levee has a constant crest elevation.

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APPENDIX B

ECONOMIC ANALYSIS

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APPENDIX B
ECONOMIC ANALYSIS

SECTION 1 - INTRODUCTION

This appendix describes the economic analysis of project alternatives for providing flood damage reduction measures for the City of Des Moines, Iowa. Current damages are caused primarily by high flows of the Des Moines and Raccoon Rivers, Walnut Creek and Fourmile Creek. The five major sections of this appendix summarize the Feasibility Report analysis conducted by the Rock Island District, U.S. Army Corps of Engineers.

Following the introductory section, the 2nd section describes the general characteristics of the study area and summarizes historical flooding. The third section presents the procedures used to quantify flood damages and the potential benefits which would accrue to a flood damage reduction project. The fourth section presents the benefit and cost analysis for the recommended plan. The fifth section summarizes the non-Federal financial analysis. Throughout this analysis, price levels are stated as of 2004, with the required Federal discount rate of 5-5/8 percent for water resources project being used to amortize costs for comparison with annualized benefits.

SECTION 2 - CHARACTERISTICS OF THE STUDY AREA

GENERAL

The City of Des Moines is the state capital, located in Polk County (central Iowa). The City is trisected by the Des Moines River and Raccoon River. Des Moines (City) has a year 2000 population of 198,700, while the Des Moines Metropolitan Statistical Area (MSA) has a year 2000 population of 483,000. Table B-1 depicts historical population trends. The metropolitan area is served by major state and Federal highways, the Interstate Highway system, railway, and airline networks.

Table B-1: Des Moines, Iowa MSA Population Trends

Year	1970	1980	1990	2000	2010 (projected)
Population	364,700	392,800	418,000	483,100	534,000

LABOR FORCE DATA

As shown in Table B-2, 2000 data indicate that the Des Moines area labor force is concentrated in the service industries, wholesale/retail trade, and insurance/finance industries. Mean household income was $78,200 in the Des Moines area, compared to $65,600 for the State of Iowa, and $77,600 for the United States.

Table B-2: Des Moines Area and State of Iowa Labor Force

2000 Projected Statistics (Woods & Poole Economics, Inc.)

Employment Category	Des Moines Area	Percent	State of Iowa	Percent
Construction & Mining	20,400	5.6	102,200	5.3
Manufacturing	25,400	7.0	266,700	13.7
Wholesale & Retail Trade	84,600	23.3	420,300	21.6
Service Industry	113,300	31.2	536,000	27.6
Finance, Insurance, Real Estate	52,000	14.3	135,000	7.0
Transportation & Utility	17,500	4.8	91,800	4.7
Farm and Farm Services	9,300	2.6	135,800	7.0
Federal Government	5,900	1.6	20,700	1.0
State & Local Government	32,200	8.9	219,200	11.3
Military	2,600	0.7	14,200	0.8
Totals	363,200	100.0	1,941,900	100.0

HISTORICAL FLOODING

The Des Moines River, Raccoon River, Walnut Creek, Fourmile Creek, and Leetown Creekway have experienced significant flooding in the past several decades, most recently in the severe region-wide 1993 flood (for study area locations, please refer to map of streams and reaches, Figure 1 in Volume 3 and the Hydraulics Appendix A). The levees (as existing at the time) protecting Reaches 1, 2, 4, 6, and 7 failed or were overtopped (or closures were not placed in a timely fashion), causing extensive damages to residential, commercial/industrial, and public properties during the 1993 flood event. Seepage pumping, sandbagging, and levee patrol, security patrol, infrastructure repair, and debris cleanup costs were incurred during and after flooding. The existing levee protecting Reach 3 (Downtown East) performed adequately (with flood fighting efforts and some post-flood repairs). The Reach 5 levee performed well and prevented flooding in the Downtown South area. Reaches 8, 9, 10 and 11 were unprotected and incurred damages to varying extents.

STUDY AREA

As shown on Plate 1 in Volume 3 (page 26), the study areas are the floodplains impacted by the Des Moines River, Raccoon River, Walnut Creek, Fourmile Creek, and Leetown Creek. Separate reaches are delineated on this plate. The study areas are located within several separate areas of the city of Des Moines. The areas vary in usage and property types. Table B-3 lists the Reaches, affecting streams, number and type of structures in the reach, estimated 500-year event damages, and alternatives analyzed. All study areas exhibit urban land use (varying densities). Redevelopment growth trends are emerging in the Downtown West Reach.

Reaches 1 and 2 have existing non-Federal levee projects in place. These are substantial levees (top-of-levee greater than 100-year profile plus 3 feet). Historical levee performance during flood events has been mixed (i.e., failures in 1993 and high maintenance efforts). Design and materials are not to USACE standards.

Reaches 3, 4, 5, 6 and 8 have existing Federal levee projects. Reaches 6 and 8 are recently completed projects which have been evaluated only for levee reliability parameters (project performance). Reaches 3, 4 and 5 are well-maintained levees (built in the 1960's) which have been evaluated for levee raise and closure improvements.

Reach 7 has a recently constructed non-Federal levee project in place, with top-of-levee elevation greater than the 250-year profile plus 3 feet. Evaluation was conducted to determine levee reliability parameters.

Reaches 9, 10 and 11 are unprotected floodplain reaches. 100-year structural levee protection was evaluated for Reach 9. Levees and buyouts for selected areas were evaluated for Reach 10. Reach 11 structural project evaluation was eliminated after determination (H&H) that the Red Rock Remedial Works Levee was not at significant risk from Four Mile Creek/Leetown Creek flows.

The flooplains in all study reaches are distinct and well-delineated. The Des Moines Metro area exhibits hilly topography intersected by several streams, so that areas outside of the delineated floodplain are not (physically) impacted by rising flood waters. Existing Federal levees are constructed with impervious "cutoff trenches" which prevent seepage. Storm sewers feed to pumping stations (at existing Federal and non-Federal levees) to remove storm runoff from interior areas. Therefore, groundwater seepage and storm sewer backup are not considered to have significant damage impacts.

Table B-3: Study Area Properties By Reach and Category

Reach Number	Reach Name	Existing Levee Protection	Affecting Stream	Residential Structures	Commercial/ Industrial Structures	Public Structures	500-Year Event Est. $Damage*	Alternatives/Conditions Evaluated
1	Birdland Park	Non-Federal Approximate 10-yr	Des Moines River	49	30	1	27,700,000	Rebuilding Existing Levee
2	Central Place	Non-Federal Approximate 10-yr	Des Moines River	1	109	2	46,000,000	Rebuilding Existing Levee
3	Downtown East	Federal (USACE) 100-yr plus	Des Moines River	227	272	9	131,000,000	Improvements to Existing Closures
4	Downtown West	Federal (USACE) 100-yr plus	Des Moines River	---	182	3	56,800,000	Improvements to Existing Closures
			Raccoon River					
5	Downtown South	Federal (USACE) 100-yr plus	Des Moines River	579	58	8	30,300,000	Improvements to Existing Closures
6	Raccoon River 205	Federal (USACE) 100-yr plus	Raccoon River	---	33	2	24,000,000	Existing Levee Reliabilities
7	Des Moines Water Works	Non-Federal 250-yr	Raccoon River	---	---	1	17,000,000	Existing Levee Reliabilities
8	West Des Moines	Federal (USACE) 100-yr plus	Raccoon River	904	227	11	63,000,000	Existing Levee Reliabilities
			Walnut Creek					
9	Walnut Creek	No Levee	Walnut Creek	12	7	---	3,565,000	New 1% Frequency Levee
10	Fourmile Creek	No Levee	Fourmile Creek	255	3	---	1,500,000	New 1% Levees for 6 Reaches
11	Leetown Creek	No Levee	Leetown Creek	86	16	7	4,700,000	Red Rock Remedial Levee Reliability

* Assumes overtopping or failure of existing levees (where levees are in place).

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WITHOUT PROJECT CONDITION

The City of Des Moines has an extensive flood control system consisting of a major upstream reservoir (Saylorville Lake Reservoir on the Des Moines River) and levees/floodwalls protecting major portions of the City from Raccoon River, Des Moines River, and Walnut Creek flooding. Most components of this system are USACE projects, planned and built incrementally (rather than systemically). There are separable areas of the system (such as Birdland Park and Central Place) which are non-Federal projects, not meeting USACE design and construction standards. In addition, due to the number of steams affecting the city, maintenance of levees and effective placement and operation of multiple required closures are ongoing (and costly) challenges.

Under the without project condition, continued greater flood risk due to substandard non-Federal levees at Birdland Park and Central place will be encountered by the City. In addition, increased flood damage risk due to inefficient downtown closure configurations will continue to be an issue. In the unprotected Reach 10 and 11 areas (Four Mile Creek and Leetown Creek), regulated floodplain building restrictions and the City floodplain property buyout program will likely result in decreasing flood impacts into the future.

CONSIDERATION OF NON-STRUCTURAL MEASURES

Most Des Moines study reaches are highly developed, levee-protected areas which are not appropriate candidates for non-structural flood damage reduction solutions. The City's aggressive buyout program has removed many at-risk properties in both Fourmile Creek and Leetown Creekway unprotected areas. More than forty structures have been removed from this floodplain in the past decade. Additional properties will likely be removed as funding becomes available. Non-structural measures (buyouts) were evaluated for selected Fourmile Creek areas. The benefit-to-cost analysis for selected areas and individual structures resulted in infeasible buyout alternatives. For example, a 103-unit mobile home park in the Four Mile Creek floodplain (and floodway) was evaluated for buyout project potential. The cost of this option was an estimated $2,150,000 (annualized, $143,000). The annual benefit of this plan (based on a .37 frequency zero damage event and maximum damages of $629,000) is $47,400. This results in a benefit-to-cost ratio of .33. Individual structure buyout B/C ratios ranged from 0.2 to 0.7. Based on these analyses (completed at a preliminary level of detail), property buyout plans were eliminated from further consideration during plan formulation.

SECTION 3 - METHODOLOGY

FLOOD DAMAGE DATA COLLECTION

Structure and content values and depth-damage estimates were collected for properties in the study area. For industrial and commercial properties, on-site interviews and county assessor's records were used to determine damageable values and depth-damage relationships for affected properties (to include structural and content damages, emergency preparedness and cleanup costs). Ground and floor elevations were determined from onsite visits (with hand level) and two-foot contour topographic mapping (with spot elevations for buildings and roadways). Throughout the study areas (especially Birdland Park, Central Place, and the Downtown Reaches), there are significant investments in commercial plant, inventory, and equipment. Most of this property is located on ground floors and is permanently placed. It is not mobile and cannot be removed during a flood threat. Inventory is stored at varying heights and is at major risk during flood threats. Therefore, it is assumed (and verified from past flood events) that any breach or overtopping of existing levees during flooding would cause immediate and severe damage to these facilities. Information from study-area occupants was used to estimate the range of potential damages resulting from a breaching or overtopping flood event.

For public properties (such as North High School in the Birdland Park area), post-flood damage records (i.e. FEMA Damage Survey Reports) and site-specific interviews were used to develop depth-damage relationships.

For residential structures, ground and floor elevations, structure type, age, size (square footage), condition and repair/replacement values were estimated from assessor's records and field surveys. This information was used with Corps of Engineers standard residential depth-percent damage relationships to estimate stage-damage curves for residential properties.

RELIABILITY OF EXISTING LEVEES AND LEVEE CLOSURES

The existing system (and reliability) of structural flood protection measures for the City of Des Moines is described in greater detail in the Plan Formulation and Hydraulics sections of this report. In general, most of the system is a Federal (USACE) construction project, with minor portions being non-Federal design and construction. The reliabilities of Federal levees have been evaluated assuming no failure to the top-of-levee. Non-Federal levee reliabilities have been evaluated by the Rock Island District Geotechnical Branch (see Appendix D for details). The existing non-Federal levees protecting the Birdland Park and Central Place separable reaches have been assigned failure probabilities as reported in Table B-4. The Des Moines Downtown (East, West, and South) levees are Federal projects. The road/bridge closures in these levees are critical during significant flood events. The reliability of these closures being placed and holding out floodwaters was estimated by the Rock Island District Engineering Division and is reported in Table B-5. The B-5 table heading "Probability of

Holding" refers to the ability of the closure structure to effectively seal the opening in the levee (road or bridge opening) during flood events. The probabilities have been estimated (by Rock Island District Engineering Division) for the sets of closures (East, West, South), rather than for individual closures or specific flood heights affecting these closures. Refer to the Hydraulics and Hydrology appendix (paragraph 3.4.5) for further explanation. These probabilities (levee and closure performance) were entered into the HEC-FDA simulation in the model's Hydraulics/Levee Features/Geotechnical Failure Analysis section.

Table B-4: Probability of Failure of Existing Non-Federal Levees

Birdland Park Reach			Central Place Reach		
Water Surface Elevation	Flood Freq.	Probability of Levee Failure	Water Surface Elevation	Flood Freq.	Probability of Levee Failure
783.8	.95	0%	777.0	.99	0%
797.8	.02	95%	792.7	.30	10%
800.8	.01	99%	796.8	.02	95%
806.0	.002	100%	799.8	.009	100%

Table B-5: Downtown Levee Closures Probability of Holding or Failing

	Probability of Holding		Probability of Failing	
Downtown Levee	Without Project	With Project	Without Project	With Project
East	.28	.81	.72	.19
South	.64	.90	.36	.10
West	.35	.86	.65	.14

RISK AND UNCERTAINTY

Table B-6 presents mean damage estimates and standard deviation of damage by category for various flood elevations for Birdland Park, Central Place, Downtown Closures and Walnut Creek study reaches. Reaches 6, 7 and 8 (all with recently constructed levees) were evaluated only to determine project performance statistics; not to evaluate the justification for project modification plans. Reach 10 (Four Mile Creek) was evaluated using conventional expected flood damage methods, due to prior study results and funding constraints (see Table B-7). The Leetown Creek area (Reach 11) was eliminated from further analysis following

determination (see Main Report Section L and the H&H appendix) that the creek (and backup from Fourmile Creek) was not a significant threat to an adjoining area of the City of Des Moines.

For Reaches 1, 2, 3, 4, 5, and 9, property/damage information was input to the Hydraulic Engineering Center Flood Damage Assessment (HEC-FDA) computer model for risk and uncertainty. This includes depreciated replacement values, first-floor elevations, stage-damage estimates, and uncertainty variables. Zero-damage points were established from topographic information, in coordination with the Hydraulic Engineering (H&H) team member (HEC-FDA data entry and model running is a joint effort with H&H personnel). The HEC-FDA model was run, sampling various hydraulic and economic variables, resulting in existing and proposed levee-height reliability statistics and annual damage/benefit information.

Table B-6: Stage, Damage, Standard Deviation (of Damages) by Reach

Reach	Elevation (NGVD)	Approx. Frequency	Commercial/ Industrial	Standard Deviation	Public	Standard Deviation	Residential	Standard Deviation	Stage Damage Totals
1. Birdland Park	790.0	0.9	0	0	0	0	0	0	0
	792.0	0.7	0	0	0	0	2	0	2
	794.0	0.24	26	23	9	10	6	0	41
	796.0	0.05	644	200	59	18	13	1	716
	798.0	0.023	2,931	462	188	58	29	2	3,148
	800.0	0.011	6,955	759	554	78	84	5	7,593
	802.0	0.006	10,449	989	992	127	193	6	11,634
	804.0	0.0035	13,965	1,089	1,689	163	302	7	15,956
	806.0	0.0023	24,328	2,147	2,934	674	402	8	27,664
Average Annual Damage			343		46		11		400
2. Central Place	789.0	0.8	0	0	0	0			0
	792.0	0.46	41	19	120	24			161
	794.0	0.085	962	90	210	25			1,172
	796.0	0.03	7,018	410	285	29			7,303
	798.0	0.016	15,843	618	373	38			16,216
	800.0	0.008	27,401	1,074	485	48			27,886
	802.0	0.0045	36,218	1,056	625	61			36,843
	804.0	0.003	41,068	1,026	729	53			41,797
	806.0	0.002	45,232	1,022	730	54			45,962
Average Annual Damage			825		31				856
3. Downtown East	800.0	0.003	0	0	0	0	0	0	0
	802.0	0.0015	124,207	21,910	3,270	577	3,765	664	131,242
	804.0	0.0006	124,463	20,686	3,719	618	4,101	682	132,283
	806.0	0.0003	134,934	21,859	4,119	667	4,161	674	143,214
Average Annual Damage			383		12		12		407

Note: (numbers are in thousands of $)

Table B-6 (Continued) Stage Damage-Standard Deviation (of Damages) by Reach and Category ($Thousands)

Reach	Elevation (NGVD)	Approx. Frequency	Commercial/ Industrial	Standard Deviation	Public	Standard Deviation	Residential	Standard Deviation	Stage Damage Totals
4. Downtown West	800.0	0.004	0	0	0	0			0
	802.0	0.002	49,263	27,070	7,535	4,140			56,798
	804.0	0.001	53,340	20,813	8,512	3,321			61,852
	806.0	0.0004	59,657	17,993	9,180	2,769			68,837
Average Annual Damage			209		12				221
5. Downtown South	798.0	0.004	0		0		0	0	0
	800.0	0.002	10,191	1,970	4,210	814	15,889	3,071	30,290
	802.0	0.001	12,495	2,204	4,532	799	17,650	3,113	34,677
	804.0	0.0005	12,843	2,135	5,155	857	19,398	3,224	37,396
	806.0	0.00015	13,980	2,265	5,710	925	19,548	3,167	39,238
Average Annual Damage			27		11		38		76
9. Walnut Creek	809.0	0.6	0	0	0	0	0	0	0
	810.0	0.54	0	0	0	0	0	0	0
	812.0	0.34	0	0	0	0	2	0.1	2
	814.0	0.18	0	0	13	3	7	0.3	20
	816.0	0.09	0	0	22	5	12	0.05	34
	818.0	0.05	0	0	32	7	27	1.5	59
	820.0	0.016	305	44	45	9	64	3.3	414
	822.0	0.006	2,076	329	65	12	96	4.6	2,237
	824.0	0.002	3,430	575	100	18	135	5.6	3,665
Average Annual Damage			50		5		6		61

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Table B-7 presents Reach 10 flood-frequency/damage information and average annual damages for six sub-reaches along Fourmile Creek. Due to funding constraints, prior study results, and the City's ongoing floodplain property buyout program in this area, the Fourmile Creek reach was felt to have minimal chance of feasibility justification. Therefore, use of the more time-consuming, costly risk and uncertainty evaluation (i.e. HEC-FDA) was not warranted. Traditional expected annual damage calculations were completed, with the summary data and results reported in Table B-7.

Table B-7: Fourmile Creek Area (Reach 10), Frequency Damage Relationships

Approximate Frequency	Reach RB-6 ('$000)	Reach RB-5 ('$000)	Reach RB-4 ('$000)	Reach RB-3 ('$000)	Reach LB-4 ('$000)	Reach LB-2 ('$000)
0.5	0.0	0.0	0.0	0.0	0.0	0.0
0.3	1.3	0.0	0.0	0.0	0.0	0.0
0.2	2.7	0.0	0.0	0.0	0.0	0.0
0.1	4.0	0.0	0.0	0.0	0.0	86.0
0.05	5.3	0.0	0.0	0.0	150.0	110.0
0.02	7.0	0.0	0.0	25.6	275.0	263.0
0.01	8.4	0.0	0.0	32.0	409.0	350.0
0.005	12.4	0.0	0.0	38.3	630.0	530.0
Average Annual Damages	1.2	0.0	0.0	1.2	12.0	14.2

EXISTING CONDITION ANNUAL BENEFITS

FLOOD DAMAGE REDUCTION

Average annual damages are the expected value of flood losses for any given year. The calculation for existing condition average annual damages, under the Hydraulic Engineering Center Flood Damage Assessment (HEC-FDA) model involves using Monte Carlo simulation for computing expected annual flood damages (mean damage obtained by integrating the damage exceedance probability curve for the study area). Uncertain parameters (error distributions around the mean) such as flow-frequency, flow-stage, and stage-damage are sampled when a simulated overtopping event occurs. HEC-FDA output includes best estimate (mean) of expected annual damage and a distribution of possible values about the mean.

Those portions of annual damages which can be prevented by construction of a project are the estimated benefits accruing to the potential project. Residual (with-project) damages are damages which could occur due to the possibility of flood events which would overtop the proposed levee improvement. See Table B-12.

REDUCED ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS

For the Birdland Park Reach and the Central Place Reach, reconstructing the existing non-Federal levees to USACE standards will result in reduced annual O&M costs to the City. The existing non-Federal levees have significant tree growth and animal burrowing which requires regular maintenance attention. Erosion repair, riprap replacement, and pump plant maintenance costs will also be reduced significantly in the with-project condition. The Rock Island District Engineering Division estimates that annual savings (benefits) in O&M costs accruing to the project will be $27,000 and $46,600, respectively, for Birdland Park and Central Place Reaches. Table B-8 enumerates annual O&M cost savings items and totals.

Implementation of closure improvement projects for the Downtown East, West and South Levees (Federal) will also result in reduced annual operation and maintenance costs. However, these cost savings are minor in dollar amount, do not impact project justification, and are therefore not quantified.

Table B-8: Annual Operation and Maintenance Cost

	Birdland Park		Central Place	
Item	Existing	With-Project	Existing	With-Project
Clearing levee slopes	10,000	0	17,000	0
Repairing animal/vegetation damage	5,000	500	5,000	500
Repairing erosion damage	5,000	500	5,000	500
Replenishing riprap	10,000	500	10,000	500
Mowing levee	5,000	6,000	5,000	6,000
Pump operation & maintenance	5,500	6,000	15,100	4,700
Maintenance of trash racks	-	-	2,000	500
Pump station O&M	-	-	2,000	2,000
Totals	$40,500	$13,500	$61,100	$14,700
Cost Savings Benefit (difference)		$27,000		$46,400

FLOOD INSURANCE ADMINISTRATIVE COST SAVINGS

Birdland Park and Central Place study area properties are not currently subject to Flood Insurance requirements, due to the existing FEMA-certified levees. Therefore, Flood Insurance Administrative Cost Savings benefits will not accrue to project implementation. This report has concluded that the existing Birdland Park and Central Place levees do not meet FEMA levee reliability standards (refer to the Geotechnical and Hydraulic/Hydrology Appendices). The levee reliability evaluations and conclusions are being provided to the City for use in addressing the certification issue.

DETOUR COST SAVINGS

2nd Avenue and 6th Avenue are much-used bridge approach roads connecting the east side of Des Moines to the west side of the City. Both east side approaches are within the Birdland Park study reach. During the 1993 flood, both approach roads were flooded, impassable, and out of use for 2-3 weeks. As the analysis below indicates, significant detour impacts ensue from the loss of use of these approach roads. Cross-river traffic and within-reach traffic are at risk. There is extensive commercial, industrial, residential, and public school vehicle traffic and access directly affected by usage of the 2nd and 6th Avenue roads and bridges. The nearest alternative bridge access is approximately two miles downstream from the Birdland Park area.

The benefits of reliable levee protection are derived from considering what would occur if no action were taken. Without reliable protection, it is assumed that the approach roads will be flooded (based on approach road low elevations) and traffic impeded with the same frequency as that with which structural flood damages will occur. The analysis below reflects that impact/frequency relationship.

Existing levee failure will force motorists to use detour routes, incurring additional costs for vehicle operation and opportunity of time. Benefits to be derived from avoided detour costs were estimated based on the following:

(a) The 2nd Avenue Bridge has an average daily traffic count of 17,800 vehicles (2002 count), as reported by the Iowa Department of Transportation. The 6th Avenue Bridge has an average daily traffic count of 17,000 vehicles.

(b) The average detour route would require an additional distance of 4.0 miles for 2nd Avenue users, and 4.4 miles for 6th Avenue. This detour would require an additional .16-hour and 18-hour of travel, respectively, at an assumed average speed of 25 miles per hour.

(c) The estimated 2004 average variable cost for operating passenger cars is $0.32 per mile. Average truck operating cost of $1.13 per mile was used for light trucks, heavy trucks, school buses, mail vehicles, and emergency vehicles. These cost estimates include maintenance, repair, tire, fuel and oil costs (operating cost references: American Automobile Association; Mid-West Truckers Association).

(d) The estimated average hourly general wage rate is approximately $11.17. An average passenger car occupancy of 1.6 adults and one child was assumed. Travel-time cost of one-third of the average local hourly wage rate was used for adults. Therefore, the opportunity cost of time for passenger cars is estimated to be $5.90 per hour per vehicle ($11.17*1.6*1/3=$5.90).

(e) The approximate hourly wage rates were used as the value of time for light truck drivers ($11.20), heavy truck drivers ($15.37), school bus drivers ($8.22), rural route mail carriers ($19.45), and emergency vehicle attendants ($12.05*2 per vehicle).

(f) As shown in Table B-9 and B-10 daily costs resulting from increased vehicle operations and lost opportunity of time amount to $43,520 and $23,258 for 2nd Avenue, and $43,894 and $23,444 for 6th Avenue.

Table B-9: Estimated Daily Traffic Analysis - Birdland Park Reach, 2nd Avenue

Vehicle Type	2nd Avenue Daily Trips	Detour Miles One Way	Operating Costs Per Mile	Added Operating Costs	Detour Time (hrs.)	Opportunity Costs Per Hour	Added Opportunity Costs
Passenger Cars	11,400	4.0	$0.32	$26,448	0.16	$5.90	$12,549
Light Trucks	4,800	4.0	1.13	21,696	0.16	11.20	8,602
Heavy Trucks	1,530	4.0	1.13	6,916	0.16	15.37	3,763
School Buses	50	4.0	1.13	226	0.16	8.22	215
Mail Vehicles	15	4.0	1.13	35	0.16	19.45	47
Emergency Vehicles	5	4.0	1.13	23	0.16	24.10	19
Totals	17,800			$43,520			$23,258

Table B-10: Estimated Daily Traffic Analysis - Birdland Park Reach, 6th Avenue

Vehicle Type	6th Avenue Daily Trips	Detour Miles One Way	Operating Costs Per Mile	Added Operating Costs	Detour Time (hrs.)	Opportunity Costs Per Hour	Added Opportunity Costs
Passenger Cars	11,400	4.4	$0.32	$29,093	0.176	$5.90	$13,804
Light Trucks	4,800	4.4	1.13	23,866	0.176	11.20	9,462
Heavy Trucks	750	4.4	1.13	3,729	0.176	15.37	2,029
School Buses	30	4.4	1.13	149	0.176	8.23	142
Mail Vehicles	15	4.4	1.13	38	0.176	19.45	51
Emergency Vehicles	5	4.4	1.13	25	0.176	24.10	21
Totals	17,000			$43,894			$23,444

(g) Des Moines River hydrographs reveal that major levee-breaching floods (such as 1993, an approximate 0.2% frequency event) will inundate bridge approaches and prevent usage for 15-20 days, depending upon the low elevations of those approach roads. The 2nd Avenue low elevation has been identified at 802.9 NGVD, while 6th Avenue has a low elevation of 797.2. Assumed levee-breaching floods which exceed these road low elevations will result in detour costs. For example, a 0.2% frequency flood would exceed the road elevation for 20 days at 6th Avenue, and 15 days at 2nd Avenue. This would result in $1,346,700 in detour costs due to 6th Avenue closure (20 x $43,894 + $23,444), and $1,001,600 due to 2nd Avenue closure (15 x $43,520 + $23,258). A linear stage/cost relationship was constructed for both bridge approaches, with zero-cost starting just below the low street elevation.

Table B-11 relates the stage/frequency/costs relationships for 2nd and 6th Avenues. Project construction would result in annualized detour cost savings benefits of $21,300 for the 500-year project.

Table B-11: Detour Cost

Stage-Damage and Average Annual Damages

Probability Of Occurrence	NGVD Elev.	2nd Ave. Detour Costs	6th Ave. Detour Costs	Total Damages	Average Annual Damages 2nd Ave. Detour Costs	6th Ave. Detour Costs	Cumulative Annual Damages
0.5		0	0	0	0	0	0
0.04	796.0	0	0	0	0	0	0
0.02	798.3	0	405,000	405,000	0	4,050	4,050
0.01	800.4	0	645,000	645,000	0	9,300	9,300
0.002	806.4	1,001,000	1,346,000	2,347,000	4,004	17,264	21,268
0		1,001,000	1,346,000	2,347,000	6,006	19,956	25,962
				Average Annual Damage			25,962

Table B-12 summarizes annual damages, benefits, and residual damage information for economically justified reach alternatives.

Table B-12: Damages and Benefits for Justified Reaches

Reach	Average Annual Flood Damages	Level of Protection	Annual Flood Damage Reduction Benefits			O&M Savings	Detour Cost Savings	Total Annual Benefits	Residual Annual Flood Damages
			Commercial	Residential	Public				
Birdland Park	$ 399,323	100-year	193,991	6,987	17,548	27,000	9,300	254,826	180,797
		250-year	238,503	8,494	22,684	27,000	15,200	311,881	129,642
		500-year	334,375	10,960	43,335	27,000	21300	436,970	10,653
Central Place	$ 856,000	100-year	593,300	0	27,500	46,400	na	667,200	235,200
		250-year	688,000	0	29,200	46,400	na	763,600	138,800
		500-year	816,900	0	31,200	46,400	na	894,500	7,900
Downtown East Closure	$ 407,500	Improvements	147,000	4,500	4,300	N/A	na	155,800	251,700
Downtown West Closure	$ 232,700	Improvements	65,000	0	8,200	N/A	na	73,200	159,500
Downtown South Closure	$ 75,800	Improvements	11,000	14,800	4,100	N/A	na	29,900	45,900

FUTURE CONDITION

In general, the existing condition floodplain in Des Moines is densely developed, with significant growth not being apparent (although the Downtown West reach does exhibit growth, and is targeted for future redevelopment by City planners). The unprotected areas of the floodplain are regulated, so that at-risk structures are not expected to increase. The City has an ongoing floodplain property buyout program for unprotected areas. Therefore, future floodplain conditions are not expected to change significantly.

SECTION 4 - BENEFIT COST ANALYSIS

GENERAL

Construction and operation and maintenance costs detailed in this report are in 2004 price levels. Interest during construction and annualized costs are computed using a 5-5/8 percent rate as mandated for Federal water resource projects. This project was analyzed for a 50-year period of analysis. Table B-13 summarizes (for example) the calculations for interest during construction and annual charges for the 500-Year alternative Levee Raise for Reach 2, Birdland Park. A table of annual charges for Birdland Park can be found in Table B-14.

Table B-13: Interest During Construction

Birdland Park 500-Year Project Example
5-5/8% Discount Rate, Mid-Year Expenditure Convention

Project Year	Project Costs	Mid-Year Periods To Base Year	Interest Factor	Accumulated Interest
1	655,000	7	0.21429	140,358
2	526,138	5	0.14876	78,269
3	1,901,431	3	0.08677	164,988
4	1,901,431	1	0.02813	53,478
Totals	$4,984,000			$437,092

Table B-14: Summary of Annual Charges

Birdland Park 500-Year Project Example
5-5/8% Discount Rate, 50-Year Evaluation Period

Description	Amount
Estimated Construction Cost	4,984,000
Interest During Construction	437,092
Total Economic Costs	$5,421,092
Interest & Amortization	326,094
Annual Operation & Maintenance	13,500
Total Annual Charges	339,594

OPTIMIZATION OF ALTERNATIVE PLANS

For the levee projects which had the greatest potential for justification (Birdland Park and Central Place), several levels/heights of protection were evaluated for benefits and costs. As indicated by the evaluation results in Table B-15, both projects reasonably optimize at the approximate 500-year design level. Incremental commercial/industrial benefits continue to rise, offsetting incremental costs, up to the 500-year design. Incremental costs of greater protection then would increase significantly due to bridge and road construction constraints.

ECONOMIC SUMMARY

Table B-15 presents a summary economic analysis for the flood damage reduction alternatives considered for each of the separable reaches evaluated. Five study reaches are economically justified for recommended construction projects. As indicated, National Economic Development (NED) benefits are reasonably maximized for Reach 1 Birdland Park with implementation of the 500-Year Alignment 2 Plan ($97,376 net benefits, 1.29 BCR). NED benefits are reasonably maximized for Reach 2 Central Place with the 500-Year Plan ($631,813 net benefits, 3.40 BCR). Improvements to the downtown levee system closures generate $115,000, $57,300, $27,900 in net benefits, and 3.8, 4.5, 15.3 Benefit-to-Cost Ratios, for the Reaches 3,4, and 5 (East, West, South), respectively.

The recreation component feature at Birdland Park is evaluated separately, and is reported in Table B-19.

Table B-15: Cost and Benefits by Reach and Plan

(2004 prices, 5-5/8% discount rate, 50-year evaluation period)

Reach and Plan	Top of Levee	Project Cost Estimate	Interest During Const.	Total First Costs	Annualized First Costs	Annual O & M Costs	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits
Reach 1 Birdland Park Study Area										
Alignment 1										
500 year		6,679,000	574,931	7,253,931	436,344	13,500	449,844	436,970	0.97	-12,874
Alignment 2										
100 year	803.3	3,618,166	343,316	3,961,482	238,294	13,500	251,794	254,826	1.01	3,032
250 year	806.3	4,047,838	372,746	4,420,584	265,910	13,500	279,410	311,881	1.12	32,471
500 year	809.5	4,984,000	437092	5,421,092	326,094	13,500	339,594	436,970	1.29	97,376
Alignment 3										
500 year		6,434,000	505,963	6,939,963	417,458	13,500	430,958	436,970	1.01	6,012
Reach 2 Central Place Study Area										
100 year	802.3	3,156,156	240,014	3,396,170	204,289	14,700	218,989	667,300	3.05	448,311
250 year	805.3	3,419,867	258,076	3,677,843	221,238	14,700	235,938	763,700	3.24	527,762
500 year	808.7	3,839,000	286,941	4,125,941	248,187	14,700	262,887	894,700	3.40	631,813
Reach 3 Downtown East Levee										
Closure Improvements		641,890	36,875	678,765	40,830	0	40,830	155,800	3.8	114,970
500 year levee		11,439,800	1,069,959	12,509,759	752,497	10,000	762,497	113,200	0.15	-649,297
Reach 4 Downtown West Levee										
Closure Improvements		259,980	14,935	274,915	16,537	0	16,537	73,800	4.5	57,263
500 year levee		4,943,400	528,686	5,472,086	329,161	10,000	339,161	96,800	0.29	-240,561
Reach 5 Downtown South Levee										
Closure Improvements		30,809	1,770	32,579	1,960	0	1,960	29,900	15.3	27,940
500 year levee		6,174,700	576,808	6,751,508	406,122	10,000	416,122	28,500	0.07	-387,622
Reach 6 Raccoon River Section 205 Levee										
Plan 1	Evaluate reliability of existing Federal levee. Levee improvement plans were eliminated during plan formulation.									

Table B-15 (continued)

Reach and Plan		Project Cost Estimate	Interest During Const.	Total First Costs	Annualized First Costs	Annual O & M Costs	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits
Reach 7 Des Moines Water Works Levee										
Plan 1	Evaluate reliability of existing Federal levee. Levee improvement plans were eliminated during plan formulation.									
Reach 8 Des Moines-West Des Moines Levee										
Plan 1	Evaluate reliability of existing Federal levee. Levee improvement plans were eliminated during plan formulation.									
Reach 9 Walnut Creek at Grand Avenue										
Plan 1		2,481,000	142,528	2,623,528	157,801	0	157,801	50,200	0.32	-107,601
Reach 10 Fourmile Creek										
Plan 1	MH Park Buyout	2,150,000	123,512	2,273,512	136,748	0	136,748	47,416	0.35	-89,332
Plan 2a	Levee LB-2	3,790,000	213,188	4,003,188	240,785	3,000	243,785	13,451	0.06	-230,334
Plan 2b	Levee LB4	2,690,000	151,313	2,841,313	170,900	3,000	173,900	11,716	0.07	-162,184
Plan 2c	Levee RB3	571,000	32,119	603,119	36,277	1,000	37,277	1,051	0.03	-36,226
Plan 2d	Levee RB4 & RB5	1,420,000	79,875	1,499,875	90,215	2,000	92,215	0	0.00	-92,215
Plan 2e	Levee RB6	165,000	9,281	174,281	10,483	1,000	11,483	1,109	0.10	-10,374
Reach 11 Leetown Creek										
Plan 1	Evaluate reliability of the Red Rock Remedial Works levee (see Plan Formulation Section and Hydraulics Appendix). Evaluation reported adequate reliabilities, therefore no Leetown Creekway structural improvements were assessed.									

PROJECT PERFORMANCE

Table B-16 reports project performance output as calculated by the HEC-FDA model. Annual and long-term exceedance probabilities (flood stages exceeding project protection) and flood-event non-exceedance probabilities are listed for justified levee modification project reaches (with-project and without-project conditions). Table A-31 in the Hydraulics and Hydrology Appendix reports performance statistics for all reaches.

Table B-16: Project Performance

Reach and Plan	Annual Exceedance Probability	Long-Term Exceedance Risk		Probability of Event Non-Exceedance	
		10 Years	50 Years	1% Event	.2% Event
Reach 1 Birdland Park					
Without Project Condition	0.28	0.96	1.00	0.17	0.00
With 500-Year (.002) Project	0.00	0.002	0.01	1.00	0.99
Reach 2 Central Place Study Area					
Without Project Condition	0.15	0.80	0.99	0.02	0.00
With 500-Year (.002) Project	0.00	0.00	0.01	0.99	0.97

SENSITIVITY ANALYSIS

Assessment of the reliability of the existing non-Federal levees currently protecting the Birdland Park and Central Place reaches is critical to the public investment evaluation of improvements to those portions of the Des Moines flood damage reduction system. The Geotechnical Analysis (Appendix D) of existing levee probabilities of failure was incorporated into the HEC-FDA evaluation of annual damages and benefits (see Table B-4). presents economic justification information for these two reaches, given a range of existing levee reliability assumptions. This information provides reviewers and decision makers with a view of the criticality of existing levee reliability assessments. The minimum reliability scenarios assign a 99% probability of failure to the existing levees when water levels reach over-bank (no levee) stage. The maximum reliability scenarios assign a 99% probability of failure to the existing levees when water levels reach 1.5 feet below the top of the existing levee (consistent with an urban design level, with 50% freeboard credit). As is evident from the information provided, assessment/assumptions of existing levee reliabilities significantly impact the outcome of the Benefit-to-Cost analysis.

Table B-17: Existing Levee Failure Sensitivity Analysis

Comparison of Recommended Plans under Varying Levee Reliabilities
(2004 prices, 5-5/8% discount rate, 50-year evaluation period)

Reach and Plan	Existing Levee Failure Analysis Assumption	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits
Reach 1 Birdland Park					
500-Year Design	Minimum Levee Reliability	339,400	459,222	1.35	119,822
500-Year Design	Feasibility Report Levee Reliability	339,400	436,970	1.29	97,570
500-Year Design	Maximum Levee Reliability	339,400	330,347	0.97	-9,053
Reach 2 Central Place Study Area					
500-Year Design	Minimum Levee Reliability	262,752	1,157,800	4.41	895,048
500-Year Design	Feasibility Report Levee Reliability	262,752	894,700	3.41	631,948
500-Year Design	Maximum Levee Reliability	262,752	278,900	1.06	16,148

RECREATION FEATURES EVALUATION

Beneficial impacts of extension and enhancement of the multi-use trail in the Birdland Park (Reach 1) study area have been evaluated using the Unit Day Value (UDV) method, as prescribed by the Principles and Guidelines (P&G). Recreation improvements are minor in scope and cost, relative to the flood damage reduction features of the project.

Proposed improvements to the existing riverfront trail system in the Birdland Park area include ramps for handicap access (Americans with Disabilities Act standards), and ramps for access from the McHenry Park neighborhood. These features are not currently available and are incorporated into the design of the upstream levee tie-off of the recommended alignment (bisecting Kiwanis Park – See Plates C-1 to C-11 in Volume 3).

The Birdland Park recreational trail segment (along the left descending bank of the Des Moines River) is the "spine" of the City's extensive trail system. This system intertwines much of the City and connects many recreational, cultural, commercial and residential areas, and venues. It is a very high-quality trail system which provides multi-use, multi-venue activities to thousands of metropolitan users and tourists each year.

Table B-18 depicts the UDV assignments and the resulting use valuations. This table reflects a minor increase (from the existing condition) in per use value due to greater accessibility provided

by the project. It also reflects greater daily/annual usage induced by provision of neighborhood and handicap access. Usage projections are based upon City of Des Moines (Parks and Recreation) assessment. Usage assumptions are considered very reasonable in view of existing usage, current and planned venue/activity connections, and current/planned urban residential development.

Table B-18: Birdland Park Levee Trail

Unit Day Value Point Assignment for General Recreation
(Guidelines for General Recreation point assignment from EGM 03-04).

Criteria	Judgment Factors	Point Assignment Existing	Point Assignment With Project
Recreation Experience	Several general activities, more than one high quality activities	17	17
Availability of Opportunity	None within 2 hour travel time	15	15
Carrying Capacity	Optimum Facilities to conduct activities	9	9
Accessibility	Good Access, high standard roads to and within site; handicap and neighborhood accessible with-project	8	11
Environmental	High esthetic quality, no factors exist that lower quality	11	11
	Total Points Assigned	60	63
Conversion of Points to Dollar Values (Ref: EGM 03-04, 1Mar 03)		$6.80	$6.91
Average Users Per Day (cross-seasonal average)		300	375
Number of Normal Usage Days		210	210
Total Average Annual User Days (usage days x users per day)		63,000	78,750
Total Annual Recreational Benefit		$428,400	$544,200
Incremental Benefit In With-Project Condition		$0	$115,800

Table B-19 presents the recreation feature benefit and cost summary. As reported, this trail improvement feature returns a 7 to 1 benefit-to-cost ratio and $99,400 in net benefits. The Birdland Park recreation analysis (UDV assignment; benefits and costs) are presented separately from the project flood damage reduction features (as summarized in Table B-15). For cost allocation purposes, all justified project components are combined in Table B-20.

Table B-19: Benefit and Cost Summary Birdland Park Recreation Trail

June 2004 Prices, 50-Yr Evaluation Period, 5-5/8%

Total Annual Benefit	$115,800
Project Costs:	
Estimated Construction Cost	242,000
Interest During Const	14,500
Total Costs to be Amortized	256,500
Annualized @ 5-5/8%, 50 years	15,400
Annual Operation and Maintenance	1,000
Total Annual Costs	$16,400
Benefit to Cost Ratio	7.1
Net Recreation Benefits	$99,400

SECTION 5 - FINANCIAL ANALYSIS

COST DISTRIBUTION

Based on current cost-sharing provisions, Federal and non-Federal costs will be distributed as shown in Table B-20. If any HTRW remediation measures are found to be required, costs for these measures will be included (non-Federal responsibilities) in the final Feasibility Study Report.

Table B-20: Project Cost Distribution

(Rounded to nearest $thousand)
Flood Damage Reduction and Recreation Features
Des Moines, Iowa

Project Alterative		Reach 1 Birdland Park Alignment 2 500-Year	Reach 1 Birdland Park Alignment 2 Recreation	Reach 2 Central Place 500-Year	Reach 3 Downtown East Closures	Reach 4 Downtown West Closures	Reach 5 Downtown South Closures	Recommended Plan Totals
Total Project Cost Estimate	$	**4,984,000**	**242,000**	**3,839,000**	**642,000**	**260,000**	**31,000**	**9,998,000**
Federal Cost Share		**3,240,000**	**121,000**	**2,495,000**	**417,000**	**169,000**	**20,000**	**6,462,000**
Non-Federal Cost Share		**1,744,000**	**121,000**	**1,344,000**	**225,000**	**91,000**	**11,000**	**3,536,000**
Lands, Damages, Relocations		728,000	0	135,000	4,000	4,000	3,000	874,000
Cash Contribution		1,016,000	121,000	1,209,000	221,000	87,000	8,000	2,662,000
Non-Federal Cost-Share Percentage		35.0%	50.0%	35.0%	35.0%	35.0%	35.0%	

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ABILITY TO PAY

Based on the provisions of Section 103 of Public Law 99-662, Des Moines, Iowa has the ability to provide the normal share percentage of project costs. This Public Law considers the magnitude of a project benefit-to-cost ratio and the per capita income of the state and county of the non-Federal sponsor. Des Moines does not qualify for reduced cost-sharing. Table B-21 summarizes the required calculation.

Table B-21: Ability-to-Pay Analysis

Des Moines, Iowa
Birdland Park, Central Place, Downtown Closures
Combined Benefit and Cost Information

Annual Cost	$662,000	Cost & Benefits
Annual Benefits	1,591,000	for Flood Damage Reduction
Total Cost	9,756,000	
Local Sponsor Share	3,415,000	
Benefit/Cost Ratio (BCR)	2.4	
Base Benefits Floor	60.1%	BCR multiplied by 25%
Standard Non-Federal Share	35%	

NOT QUALIFIED for reduced cost sharing, as the Benefit-to-Cost Ratio multiplied by 25%, and stated as a percentage, is greater than the standard cost sharing percentage (based upon the benefits test per Section 103 of Public Law 99-662, and ER 1165-2-121).

FINANCIAL CAPABILITY

The City of Des Moines, Iowa has the willingness and capability to finance its share of the cost of constructing this local flood protection project. The City intends to provide its financial requirements through annual budget appropriations (Storm Water Capital Improvements Budget). A Statement of Financial Capability (dated 11 March 2005) with project expenditure schedule and City funding documentation is included below.

Due to recent significant changes to the project schedule for Federal funding and PCA execution, the received Statement of Financial Capability (and Financing Plan) is in need of updating. A revised Statement, Financing Plan, and Commander's Assessment (reflecting the current project schedule and Fully Funded Cost Estimate) will be submitted with the Project Cooperation Agreement (PCA).

LETTER OF STATEMENT OF FINANCIAL CAPABILITY

B-28

CITY OF DES MOINES

OFFICE OF THE CITY MANAGER

ALL AMERICA CITY 1989, 1996, 1997

March 11, 2005

Colonel Duane P. Gapinski
U.S. Army Engineer District
Clock Tower Building, P.O. Box 2004
Rock Island, IL 61204-2004

Re: STATEMENT OF FINANCIAL CAPABILITY
Des Moines River, Des Moines, Iowa
Flood Damage Reduction Project

Dear Colonel Gapinski:

The City of Des Moines, Iowa, has the legal authority to enter into the Project Cooperation Agreement and to fulfill all financial obligations for completion of the project. The City understands that the current cost estimate for the entire project is $9,993,000. Of this, the City share is $3,534,000 ($2,715,000 cash and $819,000 for rights-of-way and relocation costs).

It is the City's intention to finance its share of project costs through the Storm Water Improvements section of the Capital Improvements budget, as approved by the City Council on March 7, 2005 (Roll Call No. 05-583). This funding source will be available to meet the City's requirements as shown on the attached schedule of Estimated Funding Requirements. Enclosed also is a copy of the City budget document (Flood Protection System Improvements – CIP Page SSI-14) indicating scheduled funding for this project.

The City of Des Moines has reviewed the *draft* Project Cooperation Agreement (PCA) and has found its provisions acceptable. The City strongly desires to proceed with this flood damage reduction project. If further information is needed, please do not hesitate to contact our office.

Sincerely,

Eric A. Anderson
City Manager

EAA:vdg
Enclosures
cc: Dennis Hamilton, Rock Island District – COE
Scott Ralston, Des Moines Public Works

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SCHEDULE OF ESTIMATED FUNDING REQUIREMENTS

DES MOINES, IOWA, FLOOD DAMAGE REDUCTION PROJECT

Fiscal Year	Federal Costs	Non-Federal		Total
		Cash	LERRD	
2007	$ 975,000	$ 525,000	- 0 -	$1,500,000
2008	2,237,000	763,000	819,000	3,819,000
2009	2,800,000	1,200,000	- 0 -	4,000,000
2010	447,000	227,000	- 0 -	674,000
Total	$6,459,000	$2,715,000	$819,000	$9,993,000

Notes:

1. Fiscal year refers to U.S. Government Fiscal year 1 October thru 30 September.
2. LERRD refers to lands, easements, relocations, rights-of-way, and damages.
3. The majority (estimated 90%) of right-of-way property is currently owned by the City of Des Moines.

Storm Water Improvements
Flood Protection System Improvements
2005-06/2010-11 Capital Improvements Program

Fund:	EN304	Total Project Cost:	5,818,066
Organization:	PWK990900	Cost through 2004-05	1,868,066
Project:	FLD008	Cost for Six-year Period:	3,950,000
Department Responsible:	Public Works	Cost Beyond Six-year Period:	—
General Category:	Infrastructure - Repair/Rehab	Beginning Balance - 2004-05	146,061
Wards:	N/A	Start Date:	Ongoing
Neighborhood:	N/A	End Date:	Ongoing

	COST THROUGH 2003-04	REVISED COST IN 2004-05	RECOMMENDED AND SCHEDULED FOR SIX-YEAR PERIOD					
			2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Storm Water Utility Fund	174,259	146,061	250,000	—	—	—	—	—
General Obligation Issued	1,484,667	—	—	—	—	—	—	—
Storm Water Revenue to be Issued	—	—	—	450,000	1,400,000	1,750,000	100,000	—
Other	63,079	—	—	—	—	—	—	—
TOTAL	1,722,005	146,061	250,000	450,000	1,400,000	1,750,000	100,000	—

Description:

As a result of the Des Moines and Raccoon River Feasibility Study, the U.S. Army Corps of Engineers will submit recommended flood protection system improvement projects to the U.S. Congress for authorization. Upon congressional authorization, certain flood protection improvements (upgraded levees and gates) will be eligible for federal funding (65% federal/35% local). The feasibility study will be completed in 2004-05, after which a project cooperation agreement between the City and the Corps of Engineers will be executed. Projects include: Central Place levee reconstruction; Birdland Park levee reconstruction; and levee closure reliability upgrades in the downtown area.

Criteria for Selection:

Addresses health or safety need, maintains service level, prevents or reduces future costs.

Scheduling:

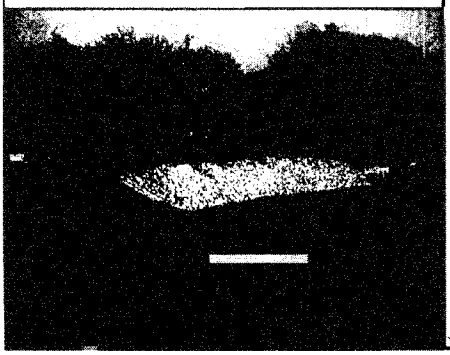
The City's portion of the design fee will be required in 2005-06. Construction of approved projects will be scheduled through 2009-10.

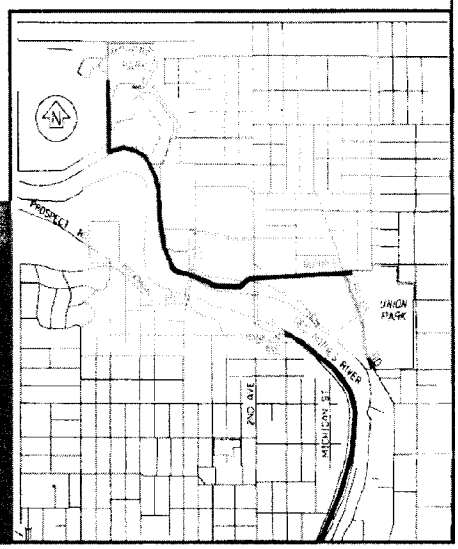
Relationship to General Plan and Other Projects:

This project complements the Riverfront Development Plan.

Operating Budget Effect:

This project should reduce operating costs associated with maintenance of river banks and portable pump station operations.





Storm Water Improvements – 14

DES MOINES/RACCOON RIVERS FEASIBILITY REPORT
DES MOINES/RACCOON RIVERS STUDY
POLK COUNTY, IOWA

APPENDIX C

ENGINEERING

DES MOINES/RACCOON RIVERS FEASIBILITY REPORT
DES MOINES/RACCOON RIVERS STUDY
POLK COUNTY, IOWA

APPENDIX C

ENGINEERING

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Figure 19 Reach 5, Permanent Closure, DM-36-R.R. SW 7th Street C-73

1. STUDY INTRODUCTION

The Des Moines and Raccoon Rivers Feasibility Study has been conducted in partnership with the City of Des Moines, Iowa (City). It includes 11 study areas within the City. (Plate 1, Volume 3.) The purpose of the study is to determine whether there is a federal interest in cost sharing flood damage reduction projects within the City to prevent recurring flood damages. The study was organized into two phases. The first phase developed new flood profiles and associated floodplain mapping. The second phase evaluated flood damage reduction alternatives to determine if there is an economic justification to implement new projects. The study generally concluded that levee reconstruction would be beneficial for the Birdland Park and Central Place Levees, Reaches 1 and 2. In addition, improvements to several of the downtown levee closures, Reaches 3,4, and 5, are recommended. Federal participation for projects in the remaining study areas was not recommended.

Primary Phase 1 accomplishments include the development of digital aerial topographic mapping in all low-lying areas in the City. The mapping combined with river cross sections were used to develop new hydraulic modeling. Profiles were used to create new digital floodplain mapping to evaluate river levels during various storm and flooding events. The models produced new floodplain profiles for the Des Moines River, Raccoon River, Walnut Creek, Fourmile Creek, and portions of Leetown Creekway. The digital mapping products were provided to the City in *Microstation J* format and in Des Moines Datum to ensure compatibility and easy integration into the City's GIS system.

Phase 2 accomplishments include several alternative levee designs. This resulted in preliminary designs and cost estimates for recommended projects at both the Birdland and Central Place Levees. Closure improvements are justified and recommended for the three downtown levee systems, Reaches 3, 4, and 5. Downtown levee raises were evaluated but not recommended for federal participation based upon to insufficient benefit to cost ratios for economic justification. The downtown levees were evaluated for structural integrity and potential improvements. New drawings were prepared that show as-built conditions and potential improvements. Potential levee improvements that were not economically justified for federal participation are shown on the drawings and provided to the City for information.

Reaches 6 and 8 represent recent U.S. Army Corps of Engineers' (Corps) levee projects completed since the 1993 floods. The Raccoon River Section 205 levee project improved an existing local levee in Reach 6 located in the Valley Drive/SW28th Street area south of the Raccoon River. Reach 8 runs along the Raccoon River from Des Moines into West Des Moines along 63rd Street. The West Des Moines – Des Moines levee project completed in 1998 provided flood protection to this reach. Both of these levee systems are functioning as designed. Further modifications or improvements are not economically justified.

The ring levee that protects the Des Moines Water Works plant represents study Reach 7. The Des Moines Water Works improved this levee after the 1993 floods with the new top-of-levee raised to above the nearby federal levee heights. Additional improvements to this levee were not evaluated as part of this study. As the Des Moines Water Works levee is not included in the Corps' Public Law (PL) 84-99 levee program, it was recommended that a levee eligibility survey report be undertaken under the authorities of the PL84-99 program.

A conceptual flood protection levee on the eastside of Walnut Creek at Grand Avenue, Reach 9, was developed and evaluated. The estimated costs of construction exceeded the estimated flood damage reduction benefits, resulting in an insufficient benefit-to-cost ratio to recommend a project for construction in this reach. For Reach 10, Fourmile Creek, the previous Corps' study report, 1975, was updated and used as a basis to evaluate flood damage reduction alternatives along Fourmile Creek. Again, an evaluation of project alternative costs in comparison to flood damage reduction benefits did not yield sufficient justification to pursue further federal interests in a structural solution along Fourmile Creek. A preliminary analysis of Leetown Creekway, Reach 11, showed insufficient benefits to pursue development of structural alternatives. Leetown Creekway is a tributary to Fourmile Creek located on the City's southeast side.

A. Topographic Product

A topographic index and associated nomenclature are presented on Plate 2. Existing topographic mapping was combined with newly acquired mapping to provide a full set. The Rock Island District Survey Branch acquired the new mapping from Aerial Services, Inc, Cedar Falls, Iowa under contract DACW25-98-D-0006. The mapping was provided in Des Moines datum, *Microstation J* format. The mapping was used to prepare the floodplain mapping, evaluate existing levees and flood potential, and as a base map for the new downtown levee drawings. The mapping is compatible with the existing GIS system in use by the City of Des Moines. It has been provided to the City for their use in digital format.

B. Hydraulic Modeling and Flood Profiles

Water surface profiles were developed using HEC-RAS Version 3.0.1. Profiles were computed from each model for flood damage analysis and for inundation mapping. The HEC-RAS models for the Des Moines River, Fourmile Creek, and Walnut Creek were modeled both in Des Moines City Datum and National Geodedic Vertical Datum (NGVD) The Raccoon River was modeled in NGVD only. The new profiles are described in Appendix A and included in Volume 3 of the report. Excerpts of the profiles are provided in a table as part of this appendix.

C. Floodplain Mapping

Floodplain mapping was prepared digitally in *Microstation J* format. This was provided to the City for use in their GIS system. Paper maps were prepared for a public meeting

and displayed for public review. Mapping is not included in this report due to the volume of material required to show the results. Results can best be seen by contacting the City and viewing the mapping on the City's GIS system.

All other study activities relating to development and evaluation of site-specific alternatives were accomplished as part of Phase 2 of the study.

References Used for Downtown Section of Report

1. EM 1110-2-1913, Design and Construction of Levees, U.S. Army Corps of Engineers, 30 April 2000
2. Contract solicitation and drawings, DACW25-67-B-0006, Flood Control Project, [Downtown East, Reach 3], 1965-1972, U.S. Army Corps of Engineers, Rock Island District
3. Contract solicitation and drawings, DACW25-70-B-0039, Flood Control Project, [Downtown West, Reach 4], 1966-1972, U.S. Army Corps of Engineers, Rock Island District
4. Contract solicitation and drawings, DACW25-70-B-0054, Flood Control Project, [Downtown South, Reach 5], 1967-1972, U.S. Army Corps of Engineers, Rock Island District
5. Operation and Maintenance Manual, City of Des Moines, Des Moines River, Raccoon River, Walnut Creek, U.S. Army Corps of Engineers, Rock Island District, October 1998, 3 Volumes.
6. Detailed Project Report for Flood Control under Section 205 of the 1948 Flood Control Act, as amended, Fourmile Creek in Des Moines, Iowa, U.S. Army Corps of Engineers, Rock Island District, May 1975.

2. REACH 1, BIRDLAND PARK LEVEE SYSTEM

A. Introduction

The U.S. Army Corps of Engineers, Rock Island District (District) contracted the design analysis for the Birdland Levee system to Stanley Consultants, Inc. (Stanley) from Muscatine, Iowa under contract DACW25-98-D-0005 0017. Stanley Consultants had previously worked on a preliminary design package for the City in 1994. The design for the City had included soil borings, survey information, and had proposed a slight levee raise. Stanley Consultants developed Alignment 1 at that time which included a floodwall located between the Des Moines Cold Storage parking lot and the oxbow lagoon at the Riverview Park as shown on Plate C1 (Note "Riverview Park" is being redeveloped by the Kiwanis as "Nature Island." Both names are currently in use.)

The District's contract with Stanley included several modifications to the 1994 design. Stanley Consultants developed designs and cost estimates for three levee heights. They also evaluated two other alignments for the upper end of Birdland Park Levee. Alignment 2 runs through Nature Island and Alignment 3 follows the existing levee and recreational trail. Stanley Consultants also developed alternatives and costs for a new closure structure at Saylor Road. This work was accomplished and is made a part of this report.

The recommended improvements for the Birdland Park Levee system are slight deviations from the Stanley design. This part of the report describes those differences and highlights significant findings from the Stanley report.

B. Assessment and History

The Birdland system protects a significant portion of the City on the left descending bank of the Des Moines River. It protects numerous businesses, residences, a public high school, and public swimming pool.

1. Assessment

According to City sources, Birdland Park (Reach 1), Central Place (Reach 2), and portions of Downtown West (Reach 3) were constructed in the 1950s, with material from Veteran's Auditorium construction. Construction procedures, including material consistency and compaction, were not documented. The three existing levee embankments therefore have many similarities, and have proven to have a high degree of uncertainty and unreliability associated with them. After the Great Flood of 1993, a PL84-99 levee rehabilitation project was undertaken for the portion of Reach 3 that was similar to the other two reaches. The extensive rehab construction revealed the randomness of the existing levee embankment material. The existing embankment was found to contain old tree stumps, construction rubble, some pervious soil material and poor compaction throughout. Excavating the inspection trench revealed more of the same. Old appliances, construction rubble, debris, and common household type garbage were encountered. Interviews with City staff, evaluation of soil borings, on-site inspections, and observations of past performance has lead the study team to conclude that both the Birdland Park and Central Place levee embankments are in a similar state.

The Birdland site inspection revealed that portions of the levee slopes are steep and eroding. Major portions of the levee are overgrown with large trees. A portion of the levee near Riverview Park is in direct contact with swift currents on an outside bend of the Des Moines River, subjecting it to erosion.

2. History

Construction of the existing levee is undocumented. In 1993, a temporary road closure, near 6th Avenue, failed, flooding the Birdland Park area. Later the entire levee system was overtopped. Prior to failure of both the Birdland Park and Central Place levees, both levees were showing signs of distress. Reported distresses were areas of excessive sponginess on the landside toe, soft spots on the landside levee slopes, poor embankment conditions around some pump station discharge pipes, and scour attacking the riverside. The same distresses were also witnessed in 1993 along the portion of the Downtown East levee (Reach 3) that shares the same past as the other two reaches. The Iowa National Guard undertook extensive flood-fighting measures to keep the SE6th-14th Street portion of Downtown East from failing. The levee was not at risk of being overtopped, but experienced serious seepage along the landside toe and saturation of the embankment, causing the ground in these areas to become very spongy.

C. Recommended Alternative

The recommended alternative for the Birdland Park Levee system is to completely reconstruct the levee to a 500-year event height along Alignment 2 through Riverview Park. Replace the existing gatewells, construct a closure structure at Saylor Road, and make all other temporary closures permanent. The proposed design also includes riprap armoring at the outside bend of the Des Moines River, and a retaining wall at the lower end of the system to accommodate the existing City park parking lot.

D. Geotechnical Evaluation

Stanley's geotechnical evaluation can be seen in the appendices to their main report. Stanley Consultants determined that the reliability of the Birdland Park Levee system was poor. The reliability assessment for the levee system—when combined with the hydrologic and hydraulic data—resulted in high chance of levee failure during a 4 percent (25-year) flood event. The upstream portion of the Birdland Park Levee has a relatively narrow embankment cross-section, has ongoing active streambank erosion in those same lengths, and is overgrown with many large mature trees. Any of these many trees could overturn in a flood event and degrade a majority of the levee embankment at that point. Following a technical review of the Stanley report by District staff, the failure analysis of the levee was adjusted as shown in the following table and graph. The risk of failure is relatively low at low water levels, but increases rapidly after river levels reach the landside toe elevation of the levee.

Table 1 Failure Analysis Table

Probability of Levee Failure	Elevation, City Datum	Elevation, NGVD	Description of Elevation
0%	10	783.8	Lowest landside grade, Sta 185+00 to 200+00
50%	24	797.8	Backside of curb, landside toe of levee, at intersection of Guthrie and Oxford Avenues, Sta 248+00
95%	27	800.8	Poor foundation conditions, trees on the levee, steep side slopes, poor levee embankment conditions and unknown construction techniques make this levee system unreliable. With the factors of safety falling below minimum standards at the landside toe, large areas of the levee unexplored, and great variance in the quality of fill found in the borings that were conducted, the level of confidence that can be placed on the existing conditions is very low.
100%	32.2	806	Lowest crown of existing levee, not including road closures, STA 243+87

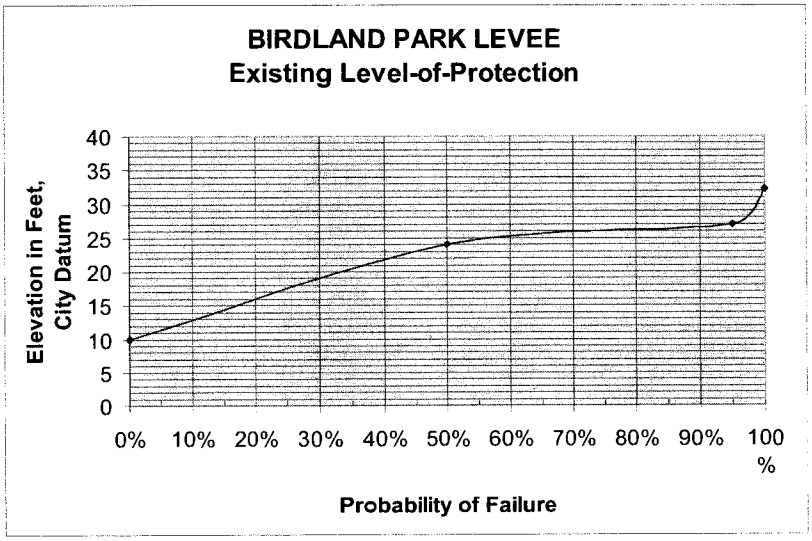

Figure 1 Existing Level of Protection, Birdland Park

The soils underlying the proposed levee through the Riverview Park include sand seams. The sand layers could contribute to underseepage during a flood event. The Stanley geotechnical analysis includes evaluation of the underseepage to determine if a cut-off wall or seepage berm is required to counteract the underseepage. Underseepage can have two adverse affects—excessive flow under the levee can lead to erosion, causing voids under the levee and possibly lead to collapse of the levee. This would likely occur during a major flood event when the underseepage is at a maximum. The second adverse effect would be the water that flows under the levee would have to be pumped out of the interior if water levels became too high. A cutoff wall can consist of an impermeable wall—such as sheet pile—that is driven through the permeable layers of soil. It can also be constructed with a slurry trench filled with an impermeable material such as a bentonite/soil mix. Stanley Consultants evaluated the alternatives and recommended that the slurry trench as sufficient and less expensive.

The Rock Island District developed a design to construct a sand berm and depression fill behind the levee rather than constructing a slurry trench. For Alignment 2, the recommended design includes a seepage berm approximately 55 feet wide with a top elevation of 25.0 ft Des Moines Datum. The depression fill extends up to 100 feet from the landside berm toe and is required to maintain a ground elevation of 21.0 ft. The design of the berm and fill section would be verified during plans and specifications development with additional borings along the final alignment. The Cost Engineering Appendix D determined that the berm would be more economical than the slurry trench or the sheet pile cutoff wall.

E. Design Considerations

1. Levee Embankment

The major portion of the existing levee embankment can be used in the proposed improvements. An inspection trench and placement of impermeable compacted embankment is recommended. Stanley Consultants recommended rebuilding the riverside face of the levee as shown on Plates C10 and C11 of their report.

2. Borrow Material

The Birdland levee project would require more than 100,000 cubic yards (cy) of compacted impermeable borrow. Searching for a borrow site took a significant amount of time. The initial site that was proposed was a 50-acre area in the floodplain north of Euclid Avenue on the west side of the river. This area is owned by the U.S. Army Corps of Engineers and managed by the Polk County Conservation District. The proposal was to develop topographic diversity to improve the existing wetlands found in the area. After coordination with local, state, and federal agencies, the District decided not to use the site and to let it develop more naturally. A search was made using aerial photography to identify open agricultural fields that could possibly be used for borrow material. These sites were considered, but again not selected because the suitable sites were private property and a long distance from the project. In the end, the City of Des Moines recommended the excess material from the I-235 project. The District geotechnical engineering, Appendix C reviewed the boring logs for this material and determined that it was suitable for the levee project. The City arranged to have the material stockpiled at the Harriet Street Landfill area, approximately five miles from the project site.

3. Utilities

Several utilities are located under or near the Birdland levee, as shown on Table 6-2, page 6-12 of the Stanley report. A major water line is located near the landside toe of the levee near Guthrie Avenue. This line should be relocated away from the levee and is included as a line item cost in the cost estimate. Existing power lines and poles are located near the levee in the landside toe near Guthrie Avenue. The poles should be relocated if possible.

4. Closure Gate Design

The recommended gate to close Saylor Road during a flood is a double leaf gate. The final design would be a gate similar to the design that the Rock Island District has used on several other projects. The gate would swing shut and then lowered into place on a concrete sill. The design shown in the Stanley report includes an older design with a required brace to support the gate. The gate would be designed so that additional supports are not required. This simplifies operation and does not require storage of the brace.

5. Seepage Berm

The two soil borings taken in the vicinity of Alignment 2 revealed a top stratum of impermeable lean clay and fill (sandy-clay) varying from 3- to 4-feet thick. But underneath are coarse-grained soils layers varying in thickness and ranging to depths of 16 to 20 feet. In order to prevent compromise of the integrity of a levee built along Alignment 2, a seepage berm 4 feet high and 55 feet wide, would have to lay behind the levee. Additionally, for a distance of up to 100 feet behind the seepage berm, all depressions and sloughs have to be filled to the elevation of the levee landside toe. The berm would protect against uplift and piping at the landward toe of the levee. Prior to final design in plans and specifications, additional borings are needed along this proposed levee alignment. The additional borings would provide better data on the engineering parameters of the foundation soils and a more detailed geotechnical analysis, allowing a more complete design of the seepage berm for the soil conditions.

6. Value Engineering

The Rock Island District added several cost saving features to the Birdland design, including the selection of Alignment 2 as the preferred alignment; having the City stockpile borrow material, and simplifying the construction of the levee by eliminating the slurry trench. None of the savings came at the expense of levee reliability or federal levee guidelines.

A more formal value engineering study (VE) was conducted by the U.S. Army Corps of Engineers, St. Paul District. The St. Paul District provided a fresh look at the levee in an attempt to find additional cost saving measures. The St. Paul District followed the VE process and provided several recommendations that were incorporated into the design. One suggestion was to use articulated concrete mats rather than stone protection along the Des Moines River. Upon initial evaluation, it appears that this may save money. It is recommended that the construction contract allow the contractor to use either system. If the contractor chooses the articulated concrete mats, it can be assumed that the construction cost would be lower.

The St. Paul District suggested reducing the size of the inspection trench from nine feet to two feet. This has potential disadvantages such as more difficulty finding unsuitable material and debris that should be removed. This area is located under the re-constructed levee and provides a foundation for the levee. Another disadvantage is that there is more difficulty in compacting

the material since smaller equipment must be mobilized and efficiencies are lower. The advantage of constructing a smaller inspection trench is that, if the material found is satisfactory, there is less excavation and compaction. This proposal was accepted and included in the design for the study. But during preparation of plans and specifications, a closer review of this recommendation should be made to ensure significant savings would be realized.

The St. Paul District reviewed quantities for the seepage berm design. St. Paul District thought that the proposed seepage berm may have been undersized and that the slurry trench would be a less expensive option. Following the VE study, further analysis was made of the seepage berm and the levee alignment. Rock Island District continues to believe that the seepage berm is properly designed based on available information and would be less expensive and easier to construct, however as stated in Geotechnical Evaluations section, additional borings and a detailed geotechnical analysis will be performed during the final design process to determine the most appropriate design, which could include a slurry trench or similar cutoff wall.

The St. Paul District recommended that unsuitable material found in the levee and inspection trench areas be disposed of on site rather than hauled off site. Organic material and trash would still require to be hauled off site; however, broken concrete and large rocks that cannot be used in the levee embankment could be placed within the seepage berm or outside of the levee template if it is covered and would not be unsightly. This recommendation was accepted and would be incorporated into a plans and specifications package.

The St. Paul District suggestion to raise Saylor Road in lieu of installing a closure gate has merit in improving flood performance, however our evaluation found raising Saylor Road too costly to be warranted. Saylor Road would need to be raised approximately nine feet to be at the same elevation as the proposed levee crest. Raising Saylor Road to go over the levee or relocating it around the levee to the east would require large amounts of fill and grading to achieve required sight distances. This design would also require extensions and/or relocations of Guthrie Avenue and the entrance to Birdland Park.

The entire value engineering study is available in the Rock Island District Office.

F. HTRW

An HTRW Phase I investigation revealed recognized environmental conditions in the Birdland Park project location, including the borrow material, due to the historical uses of the property. An HTRW Phase IIA investigation was performed in selected areas along the levee alignment to determine HTRW liability and associated costs. These conditions were confirmed via Phase IIA sampling, revealing metals and polycylclic aromatic hydrocarbons (PAH) concentrations in excess of the Iowa State Land Recycling Program Standards. Per Corps guidance Engineering Regulation (ER) 1165-2-132, contaminated land should be avoided if at all possible. However, avoidance is not a feasible option for this project. Instead, the District recommends that the City enter into the Iowa Land Recycling Program (LRP). The result of this program is a certificate of No Further Remedial Action Planned (NFRAP). It is the policy of the state of Iowa that a NFRAP certificate meets the requirements of remediation; therefore, a plot of land with a NFRAP certificate is viewed the same as a parcel without any previous contamination. It should be noted that certificates could be voided by additional, post-issuance contamination.

Corps guidance ER 1165-2-132 states clearly that construction shall not be undertaken until the sponsor, at the sponsor's expense, completes all remedial actions. Therefore, in light of the contamination identified at Birdland, construction shall not proceed until a NFRAP certificate is obtained.

Prior to submission of the feasibility report, the sponsor must supply the Corps with a letter of intent, accepting responsibility for the remediation and outlining the steps that will be taken to secure a NFRAP certificate. If this certificate is obtained prior to the submission of the feasibility report, it will be included in the HTRW Appendix. Once a project site is deemed remediated, construction may proceed.

See Appendix E for the complete HTRW analysis and results.

G. Environmental Considerations

The Birdland area includes various wetlands, forests, and open water areas in and around portions of the proposed levee alignment. Efforts were made to avoid these areas to the extent possible by adjusting the alignment. The environmental sections of the main report discuss the amount of area impacted by the proposed project and the proposed mitigation plan to address these impacts.

H. Cost

The cost to upgrade the existing levee was the most significant design consideration in finalizing the recommended design. The benefit to cost ratio is over 1.0, allowing the federal government to recommend participation in a cost shared project, but the benefits were low due to the land use of the protected area and the frequency of flooding. For this reason, minimum requirements to bring this levee up to federal guidelines were proposed. See the following tables for preliminary quantities of materials and cost estimates for the alternatives:

- Table 4 Birdland Levee, Preliminary Cost Estimate, 100-Year Height
- Table 5 Birdland Levee, Preliminary Cost Estimate, 250-Year Height
- Table 6 Birdland Levee, Preliminary Cost Estimate, 500-Year Height

I. Real Estate

Costs to acquire real estate for this project include the expenses to obtain private property where the levee footprint extends beyond existing City property line. Stanley Consultants determined the required acreage for each levee height by measuring areas using the CADD drawings and real estate overlay. The drawings are included in the Stanley report. A full real estate analysis is included in the main report. Prior to finalizing plans and specifications, a property survey should be completed to ensure that sufficient property is acquired and work areas are adequate.

J. Coordination

The Birdland Levee design included extensive coordination with the City, Stanley Consultant Inc., environmental agencies, the Kiwanis of Des Moines, and within the Rock Island District. Coordination of this scope was required in order to develop an acceptable project with optimum economic benefits.

K. Recommended Alignment

Based on preliminary results of the economic analysis, Stanley Consultants determined that Alignment 2, across the Riverview Park, would be the recommended alignment. Alignment 2 was slightly less expensive than Alignment 3 and impacted fewer wetland and open water areas. During preparation of their report, Stanley Consultants prepared a presentation of the project for the Kiwanis Club, which currently leases the land from the City. The Kiwanis are interested in developing Riverview Park as Nature Island. Their Nature Island master plan is shown in the Stanley report and contained in this Feasibility Report Volume 3. It would be a recreational opportunity to display various facets of the environment and include several features and activities such as interpretive trails, ecosystem exhibits, non-motorized boats, fishing, and a museum. The east half of the island would be the active side and include more human activities. The west half of the island would be the passive side and include less human interference. A levee across the island would preserve the existing habitat areas to the west and provide flood protection to the active side to the east. Following the presentation, some members of the Kiwanis thought that the levee would occupy too much space across the island and would rather have it constructed along Alignment 3 (the master plan showed the flood protection along Alignment 1). Alignment 1 was ruled out as being too expensive and would not have allowed federal participation in the project. Alignment 3 was slightly more expensive and disturbed significantly more wetland, forested bottomland, and open water. Additional discussions with the Kiwanis and the City Parks and Recreation Department resulted in a loose consensus that Alignment 2 was acceptable; however, the alignment might be better if it were shifted a little farther west and the berm area could be used as part of the future improvements. This was the final recommendation in the report, but would still require final coordination with the City, local interest groups, and environmental agencies.

L. Levee Height and Final Recommendation.

Stanley Consultants evaluated three levee heights, as shown in Table 3. All three levee heights are higher than the existing levee. The levee profiles exceed the river profile slope to add levee superiority at the upstream end. Alternative 2 is compatible with the level of protection of the downtown levee systems.

During preparation of the study, there was a desire to standardize alternatives and to evaluate the 100-year, 250-year, and 500-year event levee heights. These levee heights are shown in Table 2. The 100-year alternative is lower than the height of the existing levee. The 250-year alternative is about the same as the existing levee, and the 500-year alternative is higher than alternative 2 but lower than alternative 3 of Table 3. In the Birdland area, the lower alternatives require less borrow material and smaller footprint. This reduces the cost to import borrow material, obtain project right-of-way, and mitigate environmental impact. However, the economic analysis shows significantly higher benefits for the higher levee alternatives. According to the economic model and the computed B/C ratios, the 500-year alternative is the recommended plan. Alignment 2 is similar to original City guidance to keep the levee system compatible with the downtown level of protection.

M. Recreational Opportunities

The Birdland levee is located adjacent to City park areas and portions of it include existing recreational trails. It borders ball fields, tennis courts, and soccer fields. It is in close

proximity to residential areas, the high school, and public swimming pool. The recreational trails are heavily used. Analysis of projected recreation usage determined that improved recreation trails were warranted. In order to accommodate the projected trail usage, a wider levee cross section and trail was added at a relatively minor cost (Plate C10). The established cost for the recreation facilities is shown in Table 7.

Table 2 Birdland Levee Heights

Des Moines River
Polk County, Iowa
APRIL 22, 2004

DESCRIPTION	EXISTING LEVEE ELEV.* (Approx.)	STANLEY DESIGN PRELIMINARY APRIL 1994	100 yr	250 yr	500 yr
South end of system, Saylor Road, STA 259+/-	27	27	Closure gate, EL 28.9	Closure gate, EL 31.8	Closure gate, EL 35.0
STA 237+75, 2nd Ave downstream	32 (Sta 257)	33.5	29.1	32.0	35.2
STA 237+75, 2nd Ave upstream	32 (Sta 243.5)	33.8	29.5	32.4	35.6
STA 223+74.3, 6th Ave downstream		34.2	29.7	32.6	35.8
STA 223+74.3, 6th Ave upstream	33.5 (Sta 231)	34.5	30.5	33.4	36.6
Sta 200+/- At bend away from river	33.5	35.0	31.0	33.9	37.1
Upstream end of levee, STA TBD[1]	32.5	35.3	31.0	33.9	37.1

[1]The Stationing for this section will not be calculated until the final design during plans and specifications.
*Levee heights are shown in Des Moines City Datum in feet.
(City Datum Zero = 773.837 in 1929 NGVD.)

Table 3 Levee Heights Birdland Levee

DES MOINES RIVER
POLK COUNTY, IOWA
JULY 30, 2001

DESCRIPTION[1]	EXISTING LEVEE ELEV.* (Approx)	STANLEY PRELIMINARY DESIGN APRIL 1994	ALT 1	ALT 2	ALT 3
South end of system, Saylor Road, STA 259+/-	27	27	Closure gate, EL 32.0	Closure gate, EL 33.5	Closure gate, EL 36.0
STA 237+75, 2nd Ave downstream	32 (Sta 257)	33.5	32.2	33.7	36.2
STA 237+75, 2nd Ave upstream	32 (Sta 243.5)	33.8	32.5	34.1	36.6
STA 223+74.3, 6th Ave downstream		34.2	32.7	34.3	36.8
STA 223+74.3, 6th Ave upstream	33.5 (Sta 231)	34.5	33.5	35.1	37.6
Sta 200+/- At bend away from river	33.5	35.0	34.2	35.6	38.1
Upstream end of levee, STA TBD[2]	32.5	35.3	34.2	35.6	38.1

[1]Station number, existing elevations, and Stanley elevations are taken from the Stanley drawings, Birdland Levee Improvements, Review Only, April 6, 1994. Alternative levee heights 1,2, and 3 are to be used for the report design and analysis.
[2]The Stationing for this section will not be calculated until the final design during plans and specifications.
*Levee heights are shown in Des Moines capacity Datum in feet.
(City Datum Zero = 773.837 in 1929 NGVD.)

Table 4 Birdland Levee, Preliminary Cost Estimate, 100-Year Height

Birdland Alignment 2, 100 YR

Code of Accnt	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency Amount	TOTAL COST With Contg
1	**Lands and Damages**							
	Non-Federal	1	LS	$45,000.00	$45,000.00	0%	$0.00	$45,000.00
	Federal	1	LS	$610,000.00	$610,000.00	0%	$0.00	$610,000.00
	SUBTOTAL LANDS AND DAMAGES							**$655,000.00**
2	**RELOCATIONS**							
	Remove Waterline Guthrie Ave S	1,000	LF	$26.00	$26,000.00	15%	$3,900.00	$29,900.00
	Restore sidewalk and driveways Guthrie	3,500	SF	$6.50	$22,750.00	10%	$2,275.00	$25,025.00
	Replace Waterline Guthrie Ave N	1,000	LF	$52.00	$52,000.00	20%	$10,400.00	$62,400.00
	SUBTOTAL RELOCATIONS				$100,750.00			**$117,325.00**
11	**Levees and Floodwalls**							
	Silt Fence	1,600	LF	$2.65	$4,240.00	15%	$636.00	$4,876.00
	Clearing and Grubbing	8.65	AC	$5,550.00	$48,007.50	15%	$7,201.13	$55,208.63
	Strip, Stockpile/Replace Topsoil	11,000	CY	$8.75	$96,250.00	15%	$14,437.50	$110,687.50
	Seeding	14	AC	$2,870.00	$40,180.00	15%	$6,027.00	$46,207.00
	Borrow, Haul Material	57,180	CY	$7.45	$425,991.00	15%	$63,898.65	$489,889.65
	Place, Shape Embankment	75,245	CY	$4.60	$346,127.00	15%	$51,919.05	$398,046.05
	Excavation/Disposal	25,300	CY	$3.65	$92,345.00	15%	$13,851.75	$106,196.75
	Bedding	1,931	TON	$29.00	$55,999.00	10%	$5,599.90	$61,598.90
	Riprap	5,363	TON	$47.75	$256,083.25	15%	$38,412.49	$294,495.74
	6th Ave Ramp Asphalt Pavement	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45
	6th Ave Ramp Prime Coat	267	GA	$4.90	$1,308.30	15%	$196.25	$1,504.55
	6th Ave Ramp Aggregate Base Course	677	TON	$28.65	$19,396.05	15%	$2,909.41	$22,305.46
	Signage and Striping	1	LS	$1,958.00	$1,958.00	15%	$293.70	$2,251.70
	Remove and Replace 8' Chain Link Fence	100	LF	$24.85	$2,485.00	15%	$372.75	$2,857.75
	Saylor Road Closure Structure	1	LS	$114,711.00	$114,711.00	15%	$17,206.65	$131,917.65

Birdland Alignment 2, 100 YR

Code	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency	TOTAL COST
	Bike Path Asphalt Pavement	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45
	Bike Path Prime Coat	356	GA	$4.90	$1,744.40	15%	$261.66	$2,006.06
	Bike Path Aggregate Base Course	533	TON	$31.80	$16,949.40	15%	$2,542.41	$19,491.81
	Drainage Structure- Sta 201+00	1	LS	$32,878.00	$32,878.00	10%	$3,287.80	$36,165.80
	Drainage Structure Dewatering	1	LS	$39,156.00	$39,156.00	20%	$7,831.20	$46,987.20
	Demolish Gatewells A&B	1	LS	$13,052.00	$13,052.00	15%	$1,957.80	$15,009.80
	Reconstruct Gatewells A&B	1	LS	$35,240.00	$35,240.00	15%	$5,286.00	$40,526.00
	Seepage Berm	20,000	CY	$5.35	$107,000.00	15%	$16,050.00	$123,050.00
	Mitigation	1	LS	$120,875.00	$120,875.00	15%	$18,131.25	$139,006.25
	Retaining Wall	1	LS	$70,265.00	$70,265.00	15%	$10,539.75	$80,804.75
	Parking Lot Repairs	1	LS	$7,610.00	$7,610.00	15%	$1,141.50	$8,751.50
	SUBTOTAL LEVEE AND FLOODWALLS				$1,978,096.90		$294,228.49	**$2,272,325.39**
	TOTAL ESTIMATED CONSTRUCTION COST							**$2,389,650.39**
30	**Planning, Engineering and Design @ 15%**							**$358,447.56**
31	**Construction Management @ 9%**							**$215,068.53**
	TOTAL PROJECT COST							**$3,618,166.00**

NOTE: Prepared by Stanley (Birdland Levee, Des Moines River, July 2002); revised by MVR-ED-C. Construction costs included overhead and profit. Price Level May 2004

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Table 5 Birdland Levee, Preliminary Cost Estimate, 250-Year Height

Birdland Alignment 2, 250 YR

Code of Accnt	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency Amount	TOTAL COST With Contg
1	**Lands and Damages**							
	Non-Federal	1	LS	$45,000.00	$45,000.00	0%	$0.00	$45,000.00
	Federal	1	LS	$610,000.00	$610,000.00	0%	$0.00	$610,000.00
	SUBTOTAL LANDS AND DAMAGES							**$655,000.00**
2	**RELOCATIONS**							
	Remove Waterline Guthrie Ave S	1,000	LF	$26.00	$26,000.00	15%	$3,900.00	$29,900.00
	Restore sidewalk and driveways Guthrie	3,500	SF	$6.50	$22,750.00	10%	$2,275.00	$25,025.00
	Replace Waterline Guthrie Ave N	1,000	LF	$52.00	$52,000.00	20%	$10,400.00	$62,400.00
	SUBTOTAL RELOCATIONS				$100,750.00			**$117,325.00**
11	**Levees and Floodwalls**							
	Silt Fence	1,600	LF	$2.65	$4,240.00	15%	$636.00	$4,876.00
	Clearing and Grubbing	8.65	AC	$5,550.00	$48,007.50	15%	$7,201.13	$55,208.63
	Strip, Stockpile/Replace Topsoil	11,000	CY	$8.75	$96,250.00	15%	$14,437.50	$110,687.50
	Seeding	14	AC	$2,870.00	$40,180.00	15%	$6,027.00	$46,207.00
	Borrow, Haul Material	84,347	CY	$7.45	$628,385.15	15%	$94,257.77	$722,642.92
	Place, Shape Embankment	96,749	CY	$4.60	$445,045.40	15%	$66,756.81	$511,802.21
	Excavation/Disposal	25,300	CY	$3.65	$92,345.00	15%	$13,851.75	$106,196.75
	Bedding	1,931	TON	$29.00	$55,999.00	10%	$5,599.90	$61,598.90
	Riprap	5,363	TON	$47.75	$256,083.25	15%	$38,412.49	$294,495.74
	6th Ave Ramp Asphalt Pavement	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45
	6th Ave Ramp Prime Coat	267	GA	$4.90	$1,308.30	15%	$196.25	$1,504.55
	6th Ave Ramp Aggregate Base Course	677	TON	$28.65	$19,396.05	15%	$2,909.41	$22,305.46
	Signage and Striping	1	LS	$1,958.00	$1,958.00	15%	$293.70	$2,251.70
	Remove and Replace 8' Chain Link Fence	100	LF	$24.85	$2,485.00	15%	$372.75	$2,857.75
	Saylor Road Closure Structure	1	LS	$114,711.00	$114,711.00	15%	$17,206.65	$131,917.65

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Birdland Alignment 2, 250 YR

Code	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency	TOTAL COST
	Bike Path Asphalt Pavement	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45
	Bike Path Prime Coat	356	GA	$4.90	$1,744.40	15%	$261.66	$2,006.06
	Bike Path Aggregate Base Course	533	TON	$31.80	$16,949.40	15%	$2,542.41	$19,491.81
	Drainage Structure- Sta 201+00	1	LS	$32,878.00	$32,878.00	10%	$3,287.80	$36,165.80
	Drainage Structure Dewatering	1	LS	$39,156.00	$39,156.00	20%	$7,831.20	$46,987.20
	Demolish Gatewells A&B	1	LS	$13,052.00	$13,052.00	15%	$1,957.80	$15,009.80
	Reconstruct Gatewells A&B	1	LS	$35,240.00	$35,240.00	15%	$5,286.00	$40,526.00
	Seepage Berm	20,000	CY	$5.35	$107,000.00	15%	$16,050.00	$123,050.00
	Mitigation	1	LS	$120,875.00	$120,875.00	15%	$18,131.25	$139,006.25
	Retaining Wall	1	LS	$70,265.00	$70,265.00	15%	$10,539.75	$80,804.75
	Parking Lot Repairs	1	LS	$7,610.00	$7,610.00	15%	$1,141.50	$8,751.50
	SUBTOTAL LEVEE AND FLOODWALLS				$2,279,409.45		$339,425.37	**$2,618,834.82**
	TOTAL ESTIMATED CONSTRUCTION COST							**$2,736,159.82**
30	**Planning, Engineering and Design @ 15%**							**$410,423.97**
31	**Construction Management @ 9%**							**$246,254.38**
	TOTAL PROJECT COST							**$4,047,838.00**

NOTE: Prepared by Stanley (Birdland Levee, Des Moines River, July 2002); revised by MVR-ED-C.
Construction costs included overhead and profit. Price Level May 2004

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Table 6 Birdland Levee, Preliminary Cost Estimate, 500-Year Height

Birdland Alignment 2, 500 YR

Code of Accnt	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency Amount	TOTAL COST With Contg
1	**Lands and Damages**							
	Non-Federal	1	LS	$45,000.00	$45,000.00	0%	$0.00	$45,000.00
	Federal	1	LS	$610,000.00	$610,000.00	0%	$0.00	$610,000.00
	SUBTOTAL LANDS AND DAMAGES							**$655,000.00**
2	**RELOCATIONS**							
	Remove Waterline Guthrie Ave S	1,000	LF	$26.00	$26,000.00	15%	$3,900.00	$29,900.00
	Restore sidewalk and driveways Guthrie	3,500	SF	$6.50	$22,750.00	10%	$2,275.00	$25,025.00
	Replace Waterline Guthrie Ave N	1,000	LF	$52.00	$52,000.00	20%	$10,400.00	$62,400.00
	SUBTOTAL RELOCATIONS				$100,750.00			**$117,325.00**
11	**Levees and Floodwalls**							
	Silt Fence	1,600	LF	$2.65	$4,240.00	15%	$636.00	$4,876.00
	Clearing and Grubbing	9	AC	$5,550.00	$48,007.50	15%	$7,201.13	$55,208.63
	Strip, Stockpile/Replace Topsoil	11,000	CY	$8.75	$96,250.00	15%	$14,437.50	$110,687.50
	Seeding	14	AC	$2,870.00	$40,180.00	15%	$6,027.00	$46,207.00
	Borrow, Haul Material	132,740	CY	$7.45	$988,913.00	15%	$148,336.95	$1,137,249.95
	Place, Shape Embankment	145,150	CY	$4.60	$667,690.00	15%	$100,153.50	$767,843.50
	Excavation/Disposal	25,300	CY	$3.65	$92,345.00	15%	$13,851.75	$106,196.75
	Bedding	2,062	TON	$29.00	$59,798.00	10%	$5,979.80	$65,777.80
	Riprap	5,728	TON	$47.75	$273,512.00	15%	$41,026.80	$314,538.80
	6th Ave Ramp Asphalt Pavement	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45
	6th Ave Ramp Prime Coat	267	GA	$4.90	$1,308.30	15%	$196.25	$1,504.55
	6th Ave Ramp Aggregate Base Course	677	TON	$28.65	$19,396.05	15%	$2,909.41	$22,305.46
	Signage and Striping	1	LS	$1,958.00	$1,958.00	15%	$293.70	$2,251.70
	Remove and Replace 8' Chain Link Fence	100	LF	$24.85	$2,485.00	15%	$372.75	$2,857.75

Birdland Alignment 2, 500 YR

Code	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency	TOTAL COST
	Saylor Road Closure Structure	1	LS	$114,711.00	$114,711.00	15%	$17,206.65	$131,917.65
	Bike Path Asphalt Pavement	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45
	Bike Path Prime Coat	356	GA	$4.90	$1,744.40	15%	$261.66	$2,006.06
	Bike Path Aggregate Base Course	533	TON	$31.80	$16,949.40	15%	$2,542.41	$19,491.81
	Drainage Structure- Sta 201+00	1	LS	$32,878.00	$32,878.00	10%	$3,287.80	$36,165.80
	Drainage Structure Dewatering	1	LS	$39,156.00	$39,156.00	20%	$7,831.20	$46,987.20
	Demolish Gatewells A&B	1	LS	$13,052.00	$13,052.00	15%	$1,957.80	$15,009.80
	Reconstruct Gatewells A&B	1	LS	$35,240.00	$35,240.00	15%	$5,286.00	$40,526.00
	Seepage Berm	29,400	CY	$5.35	$157,290.00	15%	$23,593.50	$180,883.50
	Mitigation	1	LS	$120,875.00	$120,875.00	15%	$18,131.25	$139,006.25
	Retaining Wall	1	LS	$70,265.00	$70,265.00	15%	$10,539.75	$80,804.75
	Parking Lot Repairs	1	LS	$7,610.00	$7,610.00	15%	$1,141.50	$8,751.50
	SUBTOTAL LEVEE AND FLOODWALLS				$2,934,099.65		$437,438.95	**$3,371,538.60**
	TOTAL ESTIMATED CONSTRUCTION COST							**$3,488,863.60**
30	**Planning, Engineering and Design @ 15%**							**$523,329.54**
31	**Construction Management @ 9%**							**$313,997.72**
	TOTAL PROJECT COST							**$4,981,191.00**

NOTE: Prepared by Stanley (Birdland Levee, Des Moines River, July 2002); revised by MVR-ED-C. Construction costs included overhead and profit. Price Level May 2004

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Table 7 Birdland Recreational Costs

Code of Accnt	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency	TOTAL COST
14	**Recreational Facilities**							
	Seeding	0.5	AC	$2,620.00	$1,310.00	15%	$196.50	$1,506.50
	Borrow, Haul Material	7700	CY	$7.45	$57,365.00	15%	$8,604.75	$65,969.75
	Place, Shape Embankment	7700	CY	$4.80	$36,960.00	15%	$5,544.00	$42,504.00
	Bike Path Asphalt Pavement	560	TON	$48.75	$27,300.00	15%	$4,095.00	$31,395.00
	Bike Path Prime Coat	356	GA	$5.80	$2,064.80	15%	$309.72	$2,374.52
	Bike Path Aggregate Base Course	930	TON	$28.75	$26,737.50	15%	$4,010.63	$30,748.13
	Shoulders	490	CY	$36.85	$18,056.50	15%	$2,708.48	$20,764.98
	SUBTOTAL RECREATIONAL FACILITIES				$169,793.80			**$195,262.87**
	TOTAL ESTIMATED CONSTRUCTION COST							**$195,262.87**
30	**Planning, Engineering and Design @ 15%**							**$29,200.00**
31	**Construction Management @ 9%**							**$17,520.00**
	TOTAL PROJECT COST							**$241,982.87**

NOTE: Basis for estimate from MCACES file for Birdland Recreation. Construction costs included overhead and profit. Price Level May 2004

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3. REACH 2 CENTRAL PLACE LEVEE SYSTEM

A. Introduction

The Central Place Business District is on the near north side of the City's central business district. The area was redeveloped from primarily a residential area to a small business commercial district in the early 1970s and is now home to many businesses.

Damage resulting from the Des Moines River flood of 1947 provided the stimulus for City levee construction in the area. Accordingly, additional embankment was placed by the City in the early 1950s to provide improved flood protection. Portions of the embankment were constructed wide enough for a two- lane road. The road was never constructed. The Federal Emergency Management Agency's (FEMA) National Flood Insurance Program mapped the area showing 100-year event flood protection. However, the U.S. Army Corps of Engineers has not certified the levee, and it does not meet the minimum Public Law 84-99 levee eligibility standards for urban levees.

Most of the borrow material for the existing levee is reported to have come from the construction excavation for the Veteran's Auditorium. Veteran's Auditorium is located on the near north side of downtown Des Moines. The borrow was generally acceptable levee construction material. However, the levee material placement was generally random with no recorded compaction requirements. Additionally, subsurface exploration and seepage cutoff trenches were not part of the original construction. Details regarding remedial utility work and relocations related to the levee construction are not documented. In the subsequent years since the 1950s, the Central Place levee system has had improvements such as upgraded pump station capacity and additional levee fill. The side slopes of the existing levee are relatively steep and heavily overgrown with trees. The riverside slope is very steep and exhibits signs of erosion.

B. Assessment and History

At Des Moines, the upstream watershed of the Des Moines River totals 6,245 square miles. Following construction, the Rock Island District, U.S. Army Corps of Engineers placed Saylorville Lake flood control reservoir into operation in 1977. The reservoir is located 10 miles upstream from Des Moines, and its primary purpose is flood control. The reservoir also provides recreational opportunities, water supply, and habitat and environmental benefits. Since construction, the reservoir has significantly reduced downstream flooding. The river has several gaging stations, providing a period of record dating back to 1917.

1. Assessment

The existing Central Place Levee system begins just north of 2nd Avenue, tying into high ground near the river's right bank (west side). It extends about 1.1 miles along the river down to University Avenue. This portion of the levee is about 12 feet high and protects approximately 200 acres of highly productive business properties. Between University Avenue and Interstate 235, a distance of approximately 0.4 miles, the levee is integral with the existing riverbank that protects West River Drive and a small park area. The levee in this portion of the system is approximately two- feet high. The lower end blends into higher

ground close to the Interstate. The low area on the landside of the levee is relatively small since the ground rises quickly out of the floodplain.

The levee consists generally of earth embankment except for 222 feet of concrete floodwall between West River Drive and the river underneath University Avenue Bridge.

During preparation of this study, the City of Des Moines surveyed the entire levee system and provided results of its study to the Rock Island District in electronic formats. This information was used to locate physical features and embankment associated with the levee and the surrounding area. Soil borings from earlier levee studies and bridge construction were analyzed. Additional borings were taken to supplement the existing borings and determine geotechnical conditions down to bedrock. Interviews with City personnel revealed historical deficiencies and levee distress noted during the flood of 1993 before levee failure and overtop. Discussions and written operational guidance were reviewed to better understand subsurface utility locations and closure requirements. The City provided GIS data in the form of street and building overlays, sanitary and storm sewer overlays, and property line overlays. Numerous field site visits were made to verify field conditions. Utility companies were notified to locate existing power lines, gas lines, water lines, and fiber optic lines.

Figure 2. Central Place. Heavy tree growth, eroded levee, steep slopes

The following levee deficiencies were noted as potential problems with the existing system and do not meet minimum Corps Standards for a certified levee system. See Figure 2 through Figure 4.

Figure 3 Central Place. Erosion and undermining of levee slope, tree roots and debris.

Figure 4 Central Place. Heavy tree growth, eroded levee, steep slopes

Central Place Levee has several overgrown trees within the levee section and near the levee toes. These trees have several adverse affects. During a flood event when the water rises and the currents increase, the trees can cause localized scour that erodes portions of the levee that could lead to failure. Trees can blow down at any time. Many times, trees tend to tip over during a flood event when the ground is saturated and loses some of its strength. This can cause a large hole to form in the levee and quickly lead to levee failure. Trees shade the levee surfaces and prevent an adequate growth of grass. Lack

of grass leads to erosion. Trees tend to attract rodent activity that burrow into levees and cause loss of levee material and seepage or flow paths through the levee. Removing rodents and rodent holes from the levee is expensive if done correctly and a danger to levee integrity if done incorrectly. Trees and fallen trees prevent adequate mowing, inspection, and maintenance. Tree roots will penetrate the levee section and cause seepage paths to form. If the tree dies, the roots can rot and leave a hole in the levee embankment.

The existing levee slopes are too steep to mow and maintain. This has resulted in a lack of periodic mowing and overgrowth of trees and weeds. The levee is almost impossible to inspect and maintain. The steeper slopes are less stable and more likely to erode or fail. The levee slopes house several rodents and other burrowing animals. In places of the levee, the river has eroded into the levee section under existing tree roots, as shown in Figures 2 ,3, and 4..

The existing levee was constructed at different times by different methods. Fill material is highly variable. There are signs of pervious material, material with less than optimal compaction, debris, and tree and root growth. Pieces of concrete, bricks, and asphalt are visible along the levee top and side slopes. There are also areas where dumping is taking place including soil, concrete, trees, branches, roof shingles, tin, and other materials.

Older levee systems typically contain abandoned structures, utilities, and debris within the levee and foundation. These unidentified structures, utilities, and debris may lead to levee failure during a flood event. An aging utility such as a gas or water line could burst under pressure and destroy a significant portion of the levee. A storm or sanitary sewer could break within the levee section and lead to loss of levee material. It is also possible for a sewer line to break away from the levee system and flood the interior if river water during a flood is allowed to enter the utility and flow back under the levee.

Existing utilities penetrate the levee at several locations. Several of these utilities do not meet Corps of Engineers requirements. Many do not have adequate closure devices. Some of the utility lines are aging. There may be abandoned utilities within the levee embankment. Other utilities that pass through the line of protection could have been constructed over the line of protection, see Table 8 for a listing of utilities.

There are four existing pump stations. The three pump stations at Indiana, Clark, and Franklin Street each have two vertical turbine pumps, as shown on Table 9. Pump station capacities are 50,000; 65,000; and 33,000 gallons per minute (GPM) respectively. These pump stations were constructed in the 1960s and upgraded in 1975. The discharge pipes were lined in 1998. The City is planning on replacing the pumps with submersible turbines and reconfiguring the discharge pipes so that the highest point of the inverts are above the proposed level of protection. The pump station trash racks are fitted with automatic cleaning screens. The pump stations are fully automated.

The City constructed a fourth pump station at 2nd Avenue in 1997. This pump station has a different configuration and consists of three submersible pumps with a total capacity of 120,000 GPM. The pumps discharge into a 6 foot by 12 foot concrete box culvert. This pump station is in good condition.

The Central Place pump stations do not have a system for gravity drainage during low river conditions. The interior or protected area elevation varies from 14 feet to average lot elevations of 17 to 20 feet. The river in this area during low water conditions is 13 to 15 feet. This makes gravity drainage impractical. The City has experienced minor flooding due to large rainstorms. The streets flood first since they are lower than the surrounding lots. Most of the streets consist of paved roads with concrete curb and gutter, connected to the subsurface storm drainage system.

Between University Avenue and Interstate 235, there are gravity outlets for the storm sewers. Four of the storm sewers are equipped with sluice gates for positive closure during a flood. Seven of the storm sewers are not protected with positive closure devices.

There is an automated sluice gate on a combined sewer north of 2nd Avenue. The gatewell is lower than the proposed level of protection and located on the landside of the levee system. The outlet pipe extends 300 feet to the river adjacent to the 2nd Ave Bridge, along the toe of the levee. There is a storm sewer connected to the gatewell on the riverside of the sluice gate. The only backflow protection is from a flap gate inside the gatewell.

City operation of the levee system is outlined in Table 10. The system is relatively complex due to the number of actions required at various river levels. In many instances, sandbagging of storm sewers is required.

2. Record Floods of 1993

The Floods of 1993 devastated vast floodplain regions of the Midwest with unprecedented flood levels. Left in the wake of these record floods were monumental property damages and personal suffering. One of the most catastrophic floods of 1993 took place in the month of July. Flooding on the Des Moines and Raccoon Rivers left a lasting impact on the citizens of the Des Moines Metropolitan area. On the Des Moines River, flood levels exceeded previous 1954 record flood levels by 3 to 4 feet through the downtown reaches.

The inflow exceeded the design capacity of the Saylorville Lake flood control reservoir, ultimately reaching an elevation of 892.0 ft., NGVD. This level exceeds the design full flood control pool elevation of 890.0 by 2.0 feet. At this reservoir level, the outflows are no longer controlled or reduced through the reservoir operation. Emergency spillway flows from the reservoir occurred throughout July. The cumulative flows in the Des Moines River from Saylorville Lake, Beaver Creek and other lateral inflows exceeded the 40,000 cubic feet per second (CFS) design capacity of the downtown flood systems. A peak flow of 55,000 CFS was recorded on the Des Moines River at the 2nd Avenue stream gage. This flow exceeds a 0.2 percent chance (500-year) flood event. All non-Federal levees on the Des Moines River including the Central Place levee system were overtopped.

The Central Place **levee** system failed during the record flooding which occurred in July 1993, resulting in extensive interior flooding and millions of dollars of damage. The levee showed signs of distress (excessive seepage) and back-flooding through interior drainage pump stations prior to levee overtop. During future floods, the levee system is expected to have the same performance problems in addition to the ongoing stream bank and levee

erosion problems. Additionally, as the heavy tree growth is maturing, dead and overturned trees are becoming more of a threat to the integrity of the levee embankment.

C. Recommended Alternative

The recommended alternative for improving the Central Place levee system is to reconstruct the levee embankment to a new profile grade, see Levee Height Analysis and Recommendations. This alternative includes constructing an inspection trench, new embankment, two new gatewells, and six new pump station discharge pipes and outlets; armoring a portion of the levee with stone protection; ,and ending the levee at the University Avenue embankment.

D. Geotechnical Analysis

The U.S. Army Corps of Engineers, Rock Island District completed a geotechnical assessment of the existing levee system. The assessment reviewed existing soil data, obtained new soil data, and performed onsite inspection. This work is documented in Appendix J, *Geotechnical*. The assessment of the existing system includes a risk-based analysis that is used to develop probabilities of failure during various flood heights. This information is required to run the economic model to develop a damage curve that is used to quantify project benefits. Final results revealed that the existing deficiencies in the levee system and other unknown conditions significantly reduce the reliability of the existing levee system. Generally, the levee is reliable up to the landside toe of the levee. For higher water levels, the levee's reliability rapidly decreases. See Appendix J, *Geotechnical* for a more detailed description of levee reliability.

Analysis of the soil data and boring logs revealed that much of the existing embankment could be used in the new embankment. However, debris and unsuitable soil should be removed from the levee embankment. Due to the poor condition of the existing embankment, the geotechnical engineer recommended a complete re-build of the existing levee. See Volume 2 Appendix J, Geotechnical report.

E. Hydrology and Hydraulic Studies

This study included several hydrology and hydraulic products, including profiles, floodplain mapping, and an interior drainage study for Central Place Levee system. The profiles were used to determine the optimal levee profile. Superiority was built into the levee heights. Superiority results in the levee profile increasing upstream at a greater rate than the design flood profile. This would result in the downstream portion of the levee over-topping first if the design capacity were ever exceeded. This reduces the flow of floodwaters through the interior of the levee system and ensures that the interior water levels are not made higher or made worse by the levee system.

The interior drainage study for the Central Place Levee system can be seen in Volume 2, Appendix A, *Hydrology and Hydraulic*. The study revealed that a drainage storage basin that would reduce interior flood levels could be constructed near the Indiana pump station on a vacant City lot.. The storage basin would provide a place for storm water to collect when the pump stations are pumping at full capacity and cannot keep up with the inflow. The design for the storage basin is shown on Plates C11 and C12. The storage basin was not recommended and the design was not developed further because the City intends to sell the

vacant lot. Secondary concerns included the potential of pervious material between the excavation and the river that could result in seepage from the river to the storage basin under the levee. Also, the HTRW Phase I investigation showed the potential for contamination near this site.

F. Design Considerations

1. Levee Embankment

Levee embankment should consist of compacted impervious earth materials with sufficient cross sectional area. The embankment should not include abandoned utilities, debris, tree growth, animal burrows, or other items or deficiencies that could lead to failure of the embankment. The field and geotechnical investigations of this levee have revealed that these deficiencies do exist. The only way to ensure future levee performance is to excavate the material from the embankment to include a subsurface inspection trench. After the material is inspected and modified as required, it can be placed back into the embankment and properly compacted. The compacted impermeable material would provide a dense embankment that is resistant to erosion and would prevent water from seeping through the embankment leading to possible levee failure. Alternatives as to how much material is removed and replaced do exist. An alternative to minimize costs is to remove and replace the riverside portion of the levee. The horizontal thickness of the compacted layer is about 15 feet. This would provide sufficient room for compaction equipment and replace enough levee embankment to provide levee stability. The standard Corps inspection trench for this size levee is 6 feet deep and 8 to 10 feet wide. This cross section is shown on Plate C9. The recommended levee side slopes are 3H to 1V with a 15-foot top width. The 3H to 1V side slope is required to facilitate both operation and maintenance. The flatter slope is more stable and resistant to erosion. It is also safe to mow. The 15-foot recommended top width is wide enough to allow the City to construct a 10-foot pedestrian trail on the top of the levee with sufficient shoulders to meet Iowa and national recreational standards. It also provides an additional safety factor for levee stability. Typically the top width would be 10 feet wide. The cost for the extra width is not significant since sufficient embankment material exists on site. The landside of the levee should be graded, shaped, and seeded to provide a surface that is easily inspected and maintained.

2. Borrow Material

The recommended levee profile at the 500-year level may need minor amounts of borrow material. There are anticipated losses due to clearing and grubbing the existing embankment, stripping 6 inches of organic material from the surface, and excavating and re-compacting the levee. The soil borings revealed instances of substandard material within the embankment. Debris, organic material, and large rocks or concrete should be hauled off site and not re-used as levee embankment material. The design utilizes excess material from the extra wide cross section between stations 49+00 and 65+00.

3. Stone Protection

Most of the Central Place levee is located on the inside bend of the river and protected with significant foreshore. There is an area between stations 21+50 and 31+50 that is exposed to the channel and potential erosion. The lower portion of this levee section should be protected with riprap. The riprap rock size and layer thickness is based on similar projects along the Des Moines River. The top elevation of the rock is based on a flood frequency of 1 percent

(100 year event). When the river reaches a higher level, it is more infrequent and may not have a long duration. Experience with the Des Moines levee systems has shown that erosion above the riprap top elevation is minimal. Keeping the rock along the lower portions of the levee slope and grass above the riprap reduces construction costs and allows for easier maintenance. It is less expensive for the City to mow grass than to spray unwanted vegetation in the riprap.

4. Utilities

The utility schedule that shows levee penetrations is shown in Table 8. Utilities should be relocated over the line of protection in the freeboard section of the levee if possible. This minimizes levee damage due to line failure or utility rehabilitation. Utilities with gravity drainage or utilities where abrupt elevation changes would adversely affect their performance may have to penetrate the levee at a lower elevation. Typically these utilities are replaced with new pipe and provided with a positive closure device such as a gatewell and sluice gate. Impermeable material is compacted around the pipe. Construction is very critical since these areas become susceptible to seepage and piping action. A sand filter around the landside third of the pipe is commonly used to control any seepage or piping that may occur.

5. Pump Stations

The pump station at 2nd Avenue is relatively new, has sufficient capacity, and meets Corps of Engineer design standards. The box culvert to the river is equipped with positive closure gates. Some minor shaping and erosion protection at the outlet is required. The discharge culvert for the 2nd Avenue pump station is at elevation 33.5 feet, as shown in Table 9. If the line of protection exceeds this elevation, back-flow is possible and special operating procedures would be required.

There is some concern related to the three older pump stations.. Currently the pump discharge lines empty into a discharge chamber connected to the outlet pipe. The discharge line inverts are below the proposed level of protection. Alternatives to upgrading these pump stations follow:

Alternative I. Install flap gates on the outlet end of the pump discharge lines. Install a gatewell for positive closure on the discharge line that penetrates the levee.

Alternative II. Remove the existing discharge pipe and modify the pump station so that each pump has its own discharge pipe over the line of protection. This is the configuration that is most common for Corps of Engineers certified levee systems.

Alternative I is not preferred because it includes additional operation and maintenance expense. The gatewell would be used only in an emergency due to a break in the discharge pipe. This complicates flood fighting activities and requires constant vigilance.

Alternative II would require removal of the existing discharge pipes and installation of two new pipes at each of the three pump stations. The entire levee section would be reconstructed near the pump stations and the new pipes located over the line of protection. The pipes should be covered with embankment for levee access or a route developed landside of the pump stations. This alternative does not require operation. A gatewell is not required

since the pipes are located above the line of protection. Maintenance would be limited to the discharge pipes, air release valves, and siphon breaks. This discharge pipe configuration is recommended.

Rehabilitating the existing pump stations by installing new submersible pumps and new trash rack scrapers were originally considered for inclusion in the study and potential federal cost share. These alternatives were ruled out due to a lack of economic justification. The potential for federal involvement in replacing existing pumps and existing trash rack scrapers is very low and was not pursued further. The City has plans to replace the pumps separate from this study.

6. Construction

Construction techniques for this project are standard for the industry. Earthmoving equipment for levee excavation and reconstruction could consist of excavators, bulldozers, scrapers, and compaction equipment. Cleared and grubbed material may not be burned within the City limits. This material will be hauled off site. Following clearing, grubbing and stripping operations, the front face of the levee could be excavated and placed on top or on the landside of the levee in lifts in order to inspect the material and ensure it meets Corps levee standards. This would provide continued flood protection during construction and allow for rapid reconstruction in the event of higher discharges from Saylorville Lake. The levee should be reconstructed in sections to minimize the total amount of removal needed to expedite replacement prior to potential flood events. The inspection trench may have to be dewatered during excavation to provide a dry surface for the backfill and compaction. Compaction equipment may consist of sheepsfoot rollers, steel drum, or wheeled compaction equipment. The contractor would be required to take compaction tests as described in the geotechnical appendix in order to ensure specifications are being met. Compaction around structures and utilities may require smaller hand-operated equipment. Areas that are difficult to compact such as under pipes should be filled with flowable fill.

Erosion of new embankment is a concern. This can lead to loss of material and discharge into sewer systems and the river. To minimize erosion, the contractor should divide earthwork up into sections, and seed and mulch as soon as possible rather than leave exposed soil unprotected for an extended time period. Some areas may require the use of silt fence or other erosion control matting to protect against erosion.

Upgrading utilities and pump stations must be accomplished without diminishing flood control during construction. The contractor may have to provide portable pumping equipment or temporary discharge pipes to provide sufficient pump capacity. When constructing new utilities or gatewells, the contractor should schedule work when the river is low and not expected to rise to unacceptable levels. Work should be scheduled so that emergency backfill is possible if required.

7. Operation and Maintenance

Operation and maintenance of the improved levee system would be similar for other levee systems within the Des Moines area. The levee would have to be maintained to Corps of Engineer standards as outlined under the PL 84-99 program. The recommended improvements would facilitate operation and maintenance by simplifying operational

requirements and allowing easier access for mowing and inspection activities. The utility upgrades and replacements would require less maintenance than the existing older facilities.

8. Permits

Section 404 and 401 permits are required for this project. The proposed levee design minimizes adverse impact on existing wetland areas. In general there are wetland areas along the riverside toe of the levee. The recommended project requires clearing 15 feet beyond the levee toe to allow for maintenance and inspection activities. Mitigation is required to replace the tree loss on both the levee slopes and along the levee toe. A State Flood Plain permit is required. This should be easy to obtain since the new construction does not encroach into the existing floodplain beyond the existing levee. The flatter slope actually removes existing material from the riverside of the levee at higher elevations. A section 402, National Pollution Discharge (NPDES) permit, is required for construction activities that disturb more than 1 acre of land. This project would require this permit. The NPDES permit requires a contractor erosion control plan and monitoring project run-off to ensure erosion is not taking place.

9. Value Engineering

Because of the similarities in design, construction, and condition between Birdland Park Levee (Reach 1) and Central Place Levee (Reach 2) the value engineering conducted on the Birdland Levee by the St. Paul District will also be applied to the Central Place Levee. The recommendations made by St. Paul District follow.

Articulated concrete mat rather than stone protection along the Des Moines River will be considered. It is recommended that during development of plans and specifications, the contractor be allowed to bid on either system. If the contractor chooses the articulated concrete mat, it can be assumed that the construction cost would be lower.

Instead of using the standard 9-foot inspection trench under the levee, St. Paul District recommended a 2-foot inspection trench. Constructing a smaller inspection trench has the advantage of requiring less excavation and compaction if the material found is satisfactory. This proposal was accepted and included in the design for the study. However, during preparation of plans and specifications a closer review of this recommendation should be made to ensure significant savings would be realized.

The unsuitable material found in the levee and inspection trench area be disposed of onsite rather than hauled offsite. Organic material and trash would still have to be hauled offsite; however, any broken concrete, large rocks, etc. that cannot be used in the levee embankment could be placed outside of the levee template and covered. This recommendation is being coordinated with the City of Des Moines.

G. HTRW

An HTRW Phase I investigation revealed recognized environmental conditions in the Central Place project location, including the adjacent mitigation site, due to the historical uses of property within the protected areas. An HTRW Phase IIA investigation was performed in selected areas along the levee alignment to determine HTRW liability and associated costs. These conditions were confirmed via Phase IIA sampling, revealing metals and PAH

concentrations in excess of the Iowa State Land Recycling Program Standards. Per Corps regulation ER 1165-2-132, contaminated land should be avoided if at all possible. However, avoidance is not a feasible option for this project. Therefore, the District recommends that the City enter into the Iowa Land Recycling Program (LRP). The result of this program is a certificate of No Further Remedial Action Planned (NFRAP). It is the state's policy that a NFRAP certificate meets the requirements of remediation, therefore, a plot of land with a NFRAP certificate is viewed the same as a parcel without any previous contamination. It should be noted that certificates could be voided by additional, post-issuance contamination.

Corps regulation ER 1165-2-132 states clearly that construction shall not be undertaken until the sponsor, at the sponsor's expense, completes all remedial actions. Therefore, in light of the contamination identified at Central Place, construction shall not proceed until a NFRAP certificate is obtained.

Prior to submission of the feasibility report, the sponsor must supply the Corps with a letter of intent, accepting responsibility for the remediation and outlining the steps that will be taken to secure a NFRAP certificate. If this certificate is obtained prior to the submission of the feasibility report, it will be included in the HTRW Appendix. Once a project site is deemed remediated, construction may proceed.

See Volume 2 Appendix E, HTRW of the feasibility study report for the complete analysis and results.

H. Real Estate

Required real estate property for this project is City owned. This would simplify acquisition. Property that has not been acquired for a previous federal project is eligible for sponsor credit. The levee area plus 15 feet beyond the levee toe is involves approximately 19 acres. This includes property remnants between the landside toe and the landside property line. These areas can be used for levee access, construction staging, and temporary storage during emergency operations. The interior storm water storage basin and borrow area is 3.4 acres. The estimated cost for Lands, Easements, Rights of Way, Relocations, and Disposal Areas (LERRDS) is included in Appendix F, *Real Estate Plan.*

During the feasibility study, the City survey crews identified some of the property corners. However, the property overlay was used to compute areas. Final plans and specifications should include marking property corners where the levee abuts the property line.

I. Coordination

Close coordination was maintained with the City during preparation of this study. Discussions with City personnel who operate and maintain the system as well as the City engineering department have provided valuable information to the project design. A public meeting was held to incorporate views of citizens into the design. A review of operational requirements and existing system performance was analyzed to develop a project that optimizes performance and simplifies operation. Coordination with utility companies was made to determine requirements for relocations and upgrades. Project reviews would afford additional opportunities for the City as well as the public to coordinate their views with the District for potential improvements to the designed system.

J. Levee Height Analysis and Recommendations

Initial levee height analysis for levee alternatives is presented in **Table 11** and Table 12... Alternative 1 is similar to the existing levee height at the downstream end. The river profile and an additional foot of superiority were added to improve levee performance. Alternatives 2 and 3 are each stepped 0.9 ft higher at the index station near College Street. Alternative 3 is near the highest feasible height without adding excessive costs. At this elevation, the pump station discharge pipes and pumps would require modifications. The levee barely fits between the existing right-of-way (ROW) and floodplain area. This would likely require steeper slopes. The downstream tie-off would require additional field surveys during final design to identify whether the levee is adequately tied to high ground.

Upon the completion of the new flood profiles, three new levee heights were developed. The lowest alternative is approximately the same height as the existing levee but with an improved levee slope and added superiority. In coordination with City staff, it was not feasible to lower the height of the existing levee.

Levee alignments and quantities were developed for these three levee heights using ROADCALC and *Microstation J* modeling software. Quantity computations and computer print-outs are available from the Rock Island District Office.

For the maximum height, the City had a desire to have the Central, Birdland Park and downtown Levees offer an equivalent level of protection. Proposed alternatives were the 100-year event, the 250-year event, and the 500-year event. The 500-year event was very close to Alternative 3 and was considered the same alternative. The 100-year and 250-year events are both below the height of the existing levee system. Computer runs were made at these levels to determine new quantities. Construction of a 100-year levee system is actually more complicated than the 250-year because there is an excess of material that would likely have to be hauled off-site.

After evaluating the 100-, 250-, and 500-year alternatives in the economic model, the 500-year alternative was identified as the NED plan. The sponsor can elect to build the levee to this level or develop a locally-preferred option at a lower level.

K. Recreational Opportunities

The Central Place Levee system is currently not included in the City's long-range development plans for future use of riverfront areas. An upgraded levee in this area provides a good opportunity to extend a pedestrian trail along the riverfront. The trail could run along the proposed top of levee, or where the ROW is sufficient, along the landside base of the levee. City areas along the levee can be developed for trail access and picnic areas, resulting in turning an underused area into a productive recreational area and City attraction. Coordination with the City revealed that there are no immediate plans to construct recreational opportunities along the Central Place Levee corridor. The proposed levee design would not prevent future opportunity.

L. Cost

Screening cost estimates and final cost estimates were prepared for various levee alternatives. Final MCACES cost estimates are included in Appendix D, *Cost Engineering*. See the following tables for preliminary quantities and cost estimates for the alternatives:

- Table 13 Central Place, Preliminary Cost Estimate, 100-Year Height
- Table 14 Central Place, Preliminary Cost Estimate, 250-Year Height
- Table 15 Central Place, Preliminary Cost Estimate, 500-Year Height

The proposed levee design has been developed with cost as a major factor. The following are cost saving features of the design: First, the alignment has been developed to ensure the improved levee fits between the existing right of way and the existing floodplain. This avoids costs associated with expensive real estate acquisition and costs associated with hydraulic model studies and potential floodplain mitigation.

The proposed levee alignment ends at University Avenue. This decreases costs associated with construction, operation, and maintenance of the downstream levee area. The existing levee between University Avenue and I-235 is sufficient relative to the small park area that it protects. The tie-off was analyzed using aerial topography and a review of utility records and field site visit. These investigations should be verified with on-the-ground survey and field measurements of all utilities and elevations prior to developing the final design.

Proposed levee slopes and riprap reinforcement have been developed to minimize construction costs while facilitating future maintenance activities.

Removal and replacement of existing levee embankment has been minimized to keep costs low and to facilitate construction while maintaining flood protection.
Existing utilities have been analyzed to determine whether modifications are required to provide a high level of confidence for system performance. A listing of existing utilities and existing improvements are identified in Table 8.

Table 8 Central Place Utility Schedule, Recommended Relocations and Improvements

Station	Type of utility	Description and recommended improvement
11+26	42" RCP Storm, Invert 14.6 at existing gatewell. Top of existing gatewell 32.05	Construct new gatewell with top elevation 35.4, riverside of levee. The existing gatewell is landside of the levee and includes an 18" storm sewer outside of sluice gate. Construct 72 inch gatewell diameter with 42 inch gate.
16+00	2nd Ave pump station outlet, 12ft W by 6 ft H concrete box culvert, Invert 13.8	No work recommended. Top of gatewell in levee to close outlet is 34.8. Top of pump discharge pipes are 33.5.
23+48	Franklin pump station discharge line, 48" dia concrete with 42inch PVC liner, invert 20.4	Remove existing outlet pipes. Install new discharge pipes.
48+57	Clark St. pump station discharge line, 60" dia concrete with 48inch PVC liner, invert at outlet 18.3 ft	Remove existing outlet pipes. Install new discharge pipes.
53+30	Power lines, 69 KV underground cables	Remove power lines, reconstruct levee, relocate lines in freeboard section of levee or construct overhead
62+16	Indiana St. pump station discharge line, 54" dia concrete with 42inch PVC liner, invert	Remove existing outlet pipes. Install new discharge pipes.

Station	Type of utility	Description and recommended improvement
	19.6	
67+79	Transmission line tower near start of floodwall. Tower base, 32.97, top of flood wall, 32.65	Construct embankment around tower and wall to close gap.
68+20	36" WRA sanitary sewer.	Construct sluice gate inside a 72 inch dia. pressure manhole. Approximate invert elevation 19.90, top of gatewell 33.5 ft.
69+27	18" RCP Storm sewer, Top of gatewell 33.0, invert 19.0, 13.57 at river	Gatewell is located 6 ft from floodwall on riverside. Close gap with concrete and earth fill.
69+73	Storm sewer, 6ft H by 5ft W concrete box culvert. Invert at river 11.98	Construct gatewell
77+07	30" RCP storm sewer, invert 15.68 at river	Construct gatewell
82+47	42" RCP storm sewer with gatewell, top elevation 32.8.	Verify whether 24" RCP was combined or is still separate
85+00	WRA sewer manhole near levee	Determine effect on levee
87+00	60" Storm near freeway	Determine effect on levee
88+80	18" Storm under freeway with gatewell, 32.95	Determine effect on levee

Table 8 If levee is tied off north of University, the work below is not required.

Station	Type of utility	Description and recommended improvement
Other Utilities		
12+00	16" Water Main, cast iron	No work required. This line runs between the road and the sidewalk to the bridge. The line exists the center of the bridge abutment and is attached to the bridge
68+70	20" Water Main	No work required. This line runs along the University embankment and then attaches to the bridge.
14+00 to 62+20	3 phase 1 o aluminum buried electric line	This line is located along the center of the levee to the 2nd Ave and Franklin pump stations. Between the Franklin, Clark, and Indiana pump stations it generally follows the landside shoulder of the levee. MidAmerica estimated the depth at 3 ft deep.
12+00	Fiber Optic Lines	There is a US West line buried north of the sidewalk. This line may need to be relocated.
N/A	Gas lines	Search revealed no gas lines crossing levee

Table 9 Central Place Pump Station Summary

Pump Station Locations	Water Elev. in sump (ft)		Pump and Pipe size GPM and inches			High Invert [1] (ft)	Discharge Invert (ft) and culvert size (inches)
	Pump On	Pump Off	Pump 1	Pump 2	Pump 3		
Indiana	8	3	32000 36inch	18000 24 inch		28.25	19.6 42" Liner 54"RCP
Clark	13	8	43000 42 inch	22000 30 inch		28.64	18.3 48" liner 60"RCP
Franklin	11	6	22000 30 inch	11000 20 inch		30.75	20.4 42" liner 48"RCP
2nd Ave	21.3	15.6	40000	40000	40000	33.50	13.8 12ft W by 6ft H

Elevations are in Des Moines Datum. (El 0.0 Des Moines = 773.837 NGVD)
[1]High Invert is from City drawings; discharge invert is based on survey and field measurements.

Table 10 City Flood Operation Sequence for Central Place Levee System

This table is pulled from the 2000 OPERATIONS BY RIVER READING for the upper Des Moines River (2nd Ave. Gage) written by the City of Des Moines.

Initiate Action 2nd Ave. Gage	ACTION	Overflow ELEV. 2nd Ave. Gage	Actual ELEV. City Datum	REMARKS
18.5	Monitor CSO automatic operator - Gate 630 – northwest corner of 2nd & Franklin. If automatic not operational, close gate 630 at 19.5 (2nd Ave.)	19.7	19.5	Operated by WRA
23.5	2nd & Franklin pump station on 12'x 6' storm sewer – Close 2 north gates in station, (530C & 530D) – Open 2 east gates in station (530E & 530F) 2 gates on north, outside of station remain open (530A & 530B)	24.2	24.0	Low point intake, east gutter of 2nd Ave., north of Jefferson (secondary power)
26	Close gate 546, University & Ohio	28.1	26.1	Set 6" pump- pump from south manhole on 36" to north manhole on 6' x 5' box. Low intake northeast corner of University & Maine
27.0	Sandbag well 3 intakes on Franklin, west of 2nd Ave., if flap gate leaks	27.8	27.9	18" storm sewer in Franklin connected to CSO gate 630, with flap gate on storm.
28	Sand bag and pipe wells on manholes in 2nd Ave. from Franklin to Indiana on 60" combined sewer if surcharged	---	---	This will keep 2nd Ave. open. If 2nd & Franklin pump station non-operational, set 6" pump at 2nd & Washington – pump from intake on combined sewer east into Central Place
29.5	If power failure to Central Place pump stations, WRA to consider closing gates on storm pump stations	29.5		These stations do not have a gravity outlet
	544-Indiana & Michigan, 48" storm sewer		25.5	(secondary power)
	540-Clark & Michigan, 54" storm sewer		26.8	(secondary power)
	534-Ohio & Franklin, 42" storm sewer		28.3	(secondary power)
30.5	Close Gate 562 – W. River Dr. & Freeway	---	---	Serves 2 intakes in W. River Dr. under freeway
	Close Gate 556 – W. River Dr. north of freeway	---	---	Serves 2 storm sewer systems. Intakes are in 2nd Ave. Monitor manholes in Illinois & W. River Dr.
	Close Gate 550 – W. River Dr. & Univ.	---	---	Serves 2 intakes in W. River Dr. under Univ
31	CSO gate 630 – NW corner 2nd & Franklin	31.7	31.8	Sandbag well gate structure

Table 11 Levee Heights Central Place Levee System

DES MOINES RIVER POLK COUNTY, IOWA January 9, 2002

DESCRIPTION	APPROX EXISTING LEVEE*	ALT 1 [1]	ALT 2	ALT 3
North end of system, 2nd Ave upstream, Sta 10+00	33.7	34.4	35.4	36.6
2nd Ave downstream Sta 16+00	33.6	34.4	35.4	36.5
College Street Sta 40+50	32.5	33.1	34.0	34.9
University Ave upstream Sta 68+60	32.6 top of wall	No change	33.5	34.2
Recommended tie off is upstream of University Avenue at Station 68+69				
University Ave downstream Sta 69+20	32.6 top of wall	No change	33.4	34.1
Downstream end of levee, before I-235 Sta 88+00	Land rises to high ground. 31.0 lowest point before road.	32.9	33.1	34.1

[1]Alternative 1 is approximately 1 ft above the 500-year event, river profile, similar to the downtown levee systems.

*Levee heights are shown in Des Moines City Datum in feet. (City Datum Zero = 773.837 in 1929 NGVD.)

Table 12 Levee Heights Central Place Levee System

DES MOINES RIVER POLK COUNTY, IOWA April 22, 2004

DESCRIPTION	APPROX EXISTING LEVEE*	100 Year	250 Year [1]	500 Year
North end of system, 2nd Ave upstream, Sta 10+00	33.7	29.7	32.9	36.6
2nd Ave downstream Sta 16+00	33.6	29.7	32.9	36.5
College Street Sta 40+50	32.5	28.4	31.5	34.9
University Ave upstream [2] Sta 68+60	32.6 top of wall	No change	No change	34.2

[1]Alternative 1 is equivalent to the downtown level of protection

[2]Recommended tie off is upstream of University Avenue at Station 68+69

*Levee heights are shown in Des Moines City Datum in feet. (City Datum Zero = 773.837 in 1929 NGVD.)

Table 13 Central Place, Preliminary Cost Estimate, 100-Year Height

Central Place Preliminary Cost Estimate, 100-Year Height

Code of Accnt	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency Amount	TOTAL COST With Contg
1	**Lands and Damages**							
	Non-Federal	1	JOB	SUM	$134,500.00	0%	$0.00	$134,500.00
	Federal	1	JOB	SUM	$29,000.00	0%	$0.00	$29,000.00
	Subtotal Lands and Damages				**$163,500.00**			**$163,500.00**
11	**Levees and Floodwalls**							
	Clearing and Grubbing	70,000	SY	$1.05	$73,500.00	15%	$11,025.00	$84,525.00
	Stripping	70,000	SY	$0.40	$28,000.00	15%	$4,200.00	$32,200.00
	Embankment Foundation Preparation	490	MSF	$14.60	$7,154.00	15%	$1,073.10	$8,227.00
	Levee Embankment Cut/Fill	22,300	CY	$4.90	$109,270.00	15%	$16,390.50	$125,661.00
	Relocate/Shape/Place Imprv Embankment	59,840	CY	$8.50	$508,640.00	15%	$76,296.00	$584,936.00
	Removal of Overburden	16,670	CY	$4.90	$81,683.00	15%	$12,252.45	$93,935.00
	Borrow	17,300	CY	$7.25	$125,425.00	15%	$18,813.75	$144,239.00
	Haul Excess Material	3,000	CY	$8.15	$24,450.00	15%	$3,667.50	$28,118.00
	Relocate Existing Concrete Rubble	1,000	CY	$8.20	$8,200.00	15%	$1,230.00	$9,430.00
	Seeding of Disturbed Areas	70,000	SY	$0.70	$49,000.00	15%	$7,350.00	$56,350.00
	Bedding	1,300	TON	$29.25	$38,025.00	10%	$3,802.50	$41,828.00
	Riprap	4,200	TON	$48.00	$201,600.00	10%	$20,160.00	$221,760.00
	New Gatewell - Sta 11+26	1	JOB	SUM	$67,303.00	20%	$13,460.60	$80,764.00
	New Gatewell - Sta 68+20	1	JOB	SUM	$50,477.00	20%	$10,095.40	$60,572.00
	Relocation of Electrical	1	JOB	SUM	$37,041.00	20%	$7,408.20	$44,449.00
	Mitigation - Tree Planting	1	JOB	SUM	$89,696.00	15%	$13,454.40	$103,150.00
	Subtotal Levee and Floodwalls				**$1,499,464.00**			**$1,720,144.00**
13	**Pump Stations**							

Central Place Preliminary Cost Estimate, 100-Year Height

Code	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency	TOTAL COST
	Pump Station Modification - Indiana							
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00
	Pump Station Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$9,173.00	15%	$1,375.95	$10,549.00
	New Discharge Pipes	1	JOB	SUM	$13,688.00	20%	$2,737.60	$16,426.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$36,113.00	15%	$5,416.95	$41,530.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification – Indiana				$194,408.00			$224,884.00
	Pump Station Modification - Franklin							
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00
	Pump Station Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$8,125.00	15%	$1,218.75	$9,344.00
	New Discharge Pipes	1	JOB	SUM	$10,777.00	20%	$2,155.40	$12,932.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$35,066.00	15%	$5,259.90	$40,326.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification – Franklin				$189,402.00			$218,981.00
	Pump Station Modification - Clark							

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Central Place Preliminary Cost Estimate, 100-Year Height

Code	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency	TOTAL COST
	Excavation/Pipe Removal	1	JOB	SUM	$21,941.00	15%	$3,291.15	$25,232.00
	Pump Station Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$11,022.00	15%	$1,653.30	$12,675.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$7,884.00	15%	$1,182.60	$9,067.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$10,655.00	15%	$1,598.25	$12,253.00
	New Discharge Pipes	1	JOB	SUM	$23,146.00	20%	$4,629.20	$27,775.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$39,586.00	15%	$5,937.90	$45,524.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Clark				$215,336.00			$249,423.00
	Subtotal Pump Stations				**$599,146.00**			**$693,288.00**
	Total Estimated Construction Cost				**$2,098,610.00**			**$2,413,432.00**
30	**Planning, Engineering and Design @ 15%**							**$362,015.00**
31	**Construction Management @ 9%**							**$217,209.00**
	Total Project Cost							**$3,156,156.00**

NOTE: Prepared by MVR-ED-C. Construction costs include overhead and profit. Price Level May 2004.

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Table 14 Central Place, Preliminary Cost Estimate, 250-Year Height

Central Place Preliminary Cost Estimate, 250-Year Height

Code of Accnt	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency Amount	TOTAL COST With Contg
1	**Lands and Damages**							
	Non-Federal	1	JOB	SUM	$134,500.00	0%	$0.00	$134,500.00
	Federal	1	JOB	SUM	$29,000.00	0%	$0.00	$29,000.00
	Subtotal Lands and Damages				**$163,500.00**			**$163,500.00**
11	**Levees and Floodwalls**							
	Clearing and Grubbing	70,000	SY	$1.05	$73,500.00	15%	$11,025.00	$84,525.00
	Stripping	70,000	SY	$0.40	$28,000.00	15%	$4,200.00	$32,200.00
	Embankment Foundation Preparation	490	MSF	$14.60	$7,154.00	15%	$1,073.10	$8,227.00
	Levee Embankment Cut/Fill	22,300	CY	$4.90	$109,270.00	15%	$16,390.50	$125,661.00
	Relocate/Shape/Place Improve Embankment	68,920	CY	$8.50	$585,820.00	15%	$87,873.00	$673,693.00
	Removal of Overburden	38,660	CY	$4.90	$189,434.00	15%	$28,415.10	$217,849.00
	Borrow	17,300	CY	$7.25	$125,425.00	15%	$18,813.75	$144,239.00
	Haul Excess Material	3,000	CY	$8.15	$24,450.00	15%	$3,667.50	$28,118.00
	Relocate Existing Concrete Rubble	1,000	CY	$8.20	$8,200.00	15%	$1,230.00	$9,430.00
	Seeding of Disturbed Areas	70,000	SY	$0.70	$49,000.00	15%	$7,350.00	$56,350.00
	Bedding	1,300	TON	$29.25	$38,025.00	10%	$3,802.50	$41,828.00
	Riprap	4,200	TON	$48.00	$201,600.00	10%	$20,160.00	$221,760.00
	New Gatewell - Sta 11+26	1	JOB	SUM	$67,303.00	20%	$13,460.60	$80,764.00
	New Gatewell - Sta 68+20	1	JOB	SUM	$50,477.00	20%	$10,095.40	$60,572.00
	Relocation of Electrical	1	JOB	SUM	$37,041.00	20%	$7,408.20	$44,449.00
	Mitigation - Tree Planting	1	JOB	SUM	$89,696.00	15%	$13,454.40	$103,150.00
	Subtotal Levee and Floodwalls				**$1,684,395.00**			**$1,932,815.00**
13	**Pump Stations**							
	Pump Station Modification - Indiana							

Central Place Preliminary Cost Estimate, 250-Year Height

Code	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency	TOTAL COST
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00
	Pump Station Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$9,173.00	15%	$1,375.95	$10,549.00
	New Discharge Pipes	1	JOB	SUM	$13,688.00	20%	$2,737.60	$16,426.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$36,113.00	15%	$5,416.95	$41,530.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Indiana				$194,408.00			$224,884.00
	Pump Station Modification - Franklin							
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00
	Pump Station Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$8,125.00	15%	$1,218.75	$9,344.00
	New Discharge Pipes	1	JOB	SUM	$10,777.00	20%	$2,155.40	$12,932.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$35,066.00	15%	$5,259.90	$40,326.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Franklin				$189,402.00			$218,981.00
	Pump Station Modification - Clark							
	Excavation/Pipe Removal	1	JOB	SUM	$21,941.00	15%	$3,291.15	$25,232.00

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Central Place Preliminary Cost Estimate, 250-Year Height

Code	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency	TOTAL COST
	Pump Station Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$11,022.00	15%	$1,653.30	$12,675.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$7,884.00	15%	$1,182.60	$9,067.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$10,655.00	15%	$1,598.25	$12,253.00
	New Discharge Pipes	1	JOB	SUM	$23,146.00	20%	$4,629.20	$27,775.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$39,586.00	15%	$5,937.90	$45,524.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Clark				$215,336.00			$249,423.00
	Subtotal Pump Stations				**$599,146.00**			**$693,288.00**
	Total Estimated Construction Cost							**$2,626,103.00**
30	**Planning, Engineering and Design @ 15%**							**$393,915.00**
31	**Construction Management @ 9%**							**$236,349.00**
	Total Project Cost							**$3,419,867.00**

NOTE: Prepared by MVR-ED-C. Construction costs include overhead and profit. Price Level May 2004.

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Table 15 Central Place, Preliminary Cost Estimate, 500-Year Height

Central Place Preliminary Cost Estimate, 500-Year Height

Code of Accnt	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency Amount	TOTAL COST With Contg
1	**Lands and Damages**							
	Non-Federal	1	JOB	SUM	$134,500.00	0%	$0.00	$134,500.00
	Federal	1	JOB	SUM	$29,000.00	0%	$0.00	$29,000.00
	Subtotal Lands and Damages				**$163,500.00**			**$163,500.00**
11	**Levees and Floodwalls**							
	Clearing and Grubbing	70,000	SY	$1.05	$73,500.00	15%	$11,025.00	$84,525.00
	Stripping	70,000	SY	$0.40	$28,000.00	15%	$4,200.00	$32,200.00
	Embankment Foundation Preparation	490	MSF	$14.60	$7,154.00	15%	$1,073.10	$8,227.00
	Levee Embankment Cut/Fill	22,300	CY	$4.90	$109,270.00	15%	$16,390.50	$125,661.00
	Relocate/Shape/Place Improve Embankment	81,600	CY	$8.50	$693,600.00	15%	$104,040.00	$797,640.00
	Removal of Overburden	30,330	CY	$4.90	$148,617.00	15%	$22,292.55	$170,910.00
	Levee Tie-off at University Avenue	1	JOB	SUM	$6,705.00	20%	$1,341.00	$8,046.00
	Borrow	17,300	CY	$7.25	$125,425.00	15%	$18,813.75	$144,239.00
	Haul Excess Material	3,000	CY	$8.15	$24,450.00	15%	$3,667.50	$28,118.00
	Relocate Existing Concrete Rubble	1,000	CY	$8.20	$8,200.00	15%	$1,230.00	$9,430.00
	Seeding of Disturbed Areas	70,000	SY	$0.70	$49,000.00	15%	$7,350.00	$56,350.00
	Bedding	1,300	TON	$29.25	$38,025.00	10%	$3,802.50	$41,828.00
	Riprap	4,200	TON	$48.00	$201,600.00	10%	$20,160.00	$221,760.00
	New Gatewell - Sta 11+26	1	JOB	SUM	$67,303.00	20%	$13,460.60	$80,764.00
	New Gatewell - Sta 68+20	1	JOB	SUM	$50,477.00	20%	$10,095.40	$60,572.00
	Relocation of Electrical	1	JOB	SUM	$37,041.00	20%	$7,408.20	$44,449.00
	Mitigation - Tree Planting	1	JOB	SUM	$88,500.00	15%	$13,275.00	$101,775.00
	Subtotal Levee and Floodwalls				**$1,756,867.00**			**$2,016,494.00**
13	**Pump Stations**							

Central Place Preliminary Cost Estimate, 500-Year Height

Code	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency	TOTAL COST
	Pump Station Modification - Indiana							
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00
	Pump Station Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$9,173.00	15%	$1,375.95	$10,549.00
	New Discharge Pipes	1	JOB	SUM	$13,688.00	20%	$2,737.60	$16,426.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$36,113.00	15%	$5,416.95	$41,530.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Indiana				$194,408.00			$224,884.00
	Pump Station Modification - Franklin							
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00
	Pump Station Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$8,125.00	15%	$1,218.75	$9,344.00
	New Discharge Pipes	1	JOB	SUM	$10,777.00	20%	$2,155.40	$12,932.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$35,066.00	15%	$5,259.90	$40,326.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Franklin				$189,402.00			$218,981.00
	Pump Station Modification - Clark							

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Central Place Preliminary Cost Estimate, 500-Year Height

Code	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency	TOTAL COST
	Excavation/Pipe Removal	1	JOB	SUM	$21,941.00	15%	$3,291.15	$25,232.00
	Pump Station Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$11,022.00	15%	$1,653.30	$12,675.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$7,884.00	15%	$1,182.60	$9,067.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$10,655.00	15%	$1,598.25	$12,253.00
	New Discharge Pipes	1	JOB	SUM	$23,146.00	20%	$4,629.20	$27,775.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$39,586.00	15%	$5,937.90	$45,524.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Clark							$249,423.00
	Pump Station Modification - 2nd Avenue							
	Lengthen Discharge Pipes	1	JOB	SUM	$4,890.00	20%	$978.00	$5,868.00
	New Submersible Pumps	3	EA	$68,580.00	$205,740.00	20%	$41,148.00	$246,888.00
	Subtotal Pump Station - 2nd Avenue				$210,630.00			$252,756.00
	Subtotal Pump Stations				**$594,440.00**			**$946,044.00**
	Total Estimated Construction Cost				**$2,351,307.00**			**$2,962,538.00**
30	**Planning, Engineering and Design @ 15%**							**$444,381.00**
31	**Construction Management @ 9%**							**$266,628.00**
	Total Project Cost							**$3,837,047.00**

NOTE: Prepared by MVR-ED-C. Construction costs include overhead and profit. Price Level May 2004.

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4. REACHES 3, 4, and 5 DOWNTOWN LEVEE SYSTEMS

A. Introduction

The downtown levee systems consist of three systems protecting the downtown business district from flooding on the Raccoon and Des Moines Rivers. The Downtown West Levee, Reach 4, protects the City north of the Raccoon River and west of the Des Moines River. See City Site Plan, Plate 1 Volume 3. The Downtown East Levee, Reach 3 protects the City east and north of the Des Moines River. The Downtown South Levee, Reach 5, protects the City south of the Raccoon and Des Moines Rivers.

The purpose of this study relative to the three downtown levee systems is to determine what improvements if any are economically justified and would warrant federal involvement in a levee project. The Rock Island District and the City have maintained a close working relationship concerning operation and maintenance of these levees. Since the upgrades in the early 1970s, the Corps has provided annual assistance inspections and assistance during major flood events. The Great Flood of 1993 exceeded the design capacity of the system and identified areas of weakness. General findings of this portion of the study are summarized below. Following the findings is a more detailed description of the study process and results.

B. Assessment and History

Upstream of the City of Des Moines, the watershed of the Des Moines River totals 6,245 square miles. To minimize flooding on the Des Moines River, the Rock Island District constructed the Saylorville Lake flood control reservoir which began operation in 1977. The reservoir is located 10 miles upstream from Des Moines. Its primary purpose is flood control, but also provides recreational opportunities, water supply, and habitat and environmental benefits. Since construction, the reservoir has significantly reduced downstream flooding. The river has several gaging stations, providing a period of record dating back to 1917. The Raccoon River and other tributaries are not regulated with a reservoir and therefore, have increased potential to cause flooding in the Des Moines Area.

The U.S. Army Corps of Engineers, Rock Island District and the City entered into a cost share agreement to design and construct downtown levee system improvements between 1965 and 1972. Since construction, the City has operated and maintained the levee systems to include pump station construction and upgrades. The drawings in Volume 3 of the feasibility study reports show the general layout of the levee systems and identify pertinent features of the existing system.

1. Assessment

During this study, the design team conducted field investigations and reviewed as-built drawings, topographic drawings, and City improvements to the system. Discussions with the City revealed a need to upgrade portions of the levee system in order to provide more reliable flood protection.

Two goals of the City were to determine whether levee improvements were justified, and to reduce the labor required during flood fighting. The Great Flood of 1993 strained the City's resources. City staff had a difficult time tending to required flood fighting activities during the event, being overwhelmed with both system operation and levee reinforcement. Flood fight operations include opening and closing sluice gates, operating and maintaining permanent and temporary pump station equipment, making road and railroad closures, and performing continuous inspection and monitoring of the levees for signs of distress.

The study determined that existing federally constructed levees were structurally competent to withstand floodwaters up to the height of the system. To determine if higher levees were justified, a cost was calculated to increase embankments, raise floodwalls, and purchase real estate. These costs were compared with economic benefits for the higher level of protection. Raising the levee systems was not economically justified.

An analysis of constructing the required levee closures in the warning time provided by a major flood on the Des Moines or Raccoon Rivers, such as the 1993 floods, identified response time concerns. Hydrology and hydraulic analysis on the Raccoon River concluded the Van Meter stream gage on the Raccoon River provides a definitive advance flood warning to the downstream areas. The rate of rise to peak at Van Meter is typically greater than 36 hours for major floods and hydraulic travel time to the City of Des Moines is approximately 12 to 18 hours. These advance warning times of approximately 2 days provided the design parameter in evaluating the type and number of closures that must be operated in the flood protection systems on the Raccoon River.

The advance flood warning times on the Des Moines River would typically be comparable to the Raccoon River. However, due to the stream regulation provided by the upstream Saylorville Lake, typical warning times cannot be applied to the Des Moines River. The determination of advance flood warning times on the Des Moines River in Des Moines requires a thorough understanding of the U.S. Army Corps of Engineers' Saylorville Lake regulation plan and lateral inflow characteristics below the reservoir.

Saylorville Dam is located only 10 miles upstream from downtown Des Moines. Hydraulic travel time on the Des Moines River from the dam to the confluence with the Raccoon River is four hours. Thus, regulation changes in outflow from Saylorville Lake rapidly reach Des Moines, affecting some levee systems in less than three hours. Under normal operating conditions at the lake (lake elevations less than 884.0 NGVD), these regulation changes do not cause significant flood concerns as the outflows are regulated to limit downstream Des Moines River levels to non-damaging stages. The primary target is to maintain the Des Moines River levels at or below a stage of 24 feet at the SE 6th Street stream gage. However, once lake elevations exceed 884 NGVD, downstream river level constraints are waived and a constant outflow of 21,000 cfs is maintained until the reservoir pool rises to elevation 889 NGVD. Once elevation 889 is exceeded, the spillway's pneumatic dam is slowly lowered until a Saylorville Lake outflow of 42,000

cfs is reached at pool elevation 890 NGVD. For pool elevations exceeding 890 NGVD, uncontrolled outflow is experienced from the lake.

As prescribed by the regulation plan, the Corps of Engineers cannot reduce outflows from Saylorville Lake to reduce downstream flooding once the reservoir is in emergency operation above pool elevation 884 NGVD. As such, a constant 21,000 cfs is discharged to the downstream Des Moines River channel. This flow rate coupled with rapidly rising lateral inflows from Beaver Creek and numerous other urban tributaries can result in flash flood conditions, less than six hours, on the Des Moines River through the City including the downtown reaches where numerous levee closures are required on the existing system.

Based on emergency response coordination with the City of Des Moines during the design and construction of recent levee projects, advance warning times in excess of 24 hours were determined to be required for a closure that required significant mobilization such as street traffic closures and installation of a temporary clay levee closure embankment. Due to manpower limitations during flood emergencies, the City has typically relied upon placing temporary clay plugs instead of sandbag dikes for making the closure.

Analysis of the City's levee closure requirements showed that closures could be improved by minimizing the openings and permanently closing other openings. The closure improvements are recommended and more fully discussed below. Detailed structural analysis was not accomplished as part of the study. Costs to make improvements were estimated based on closure configuration at each site. During preparation of plans and specifications, the structural analysis and final design coordination will be required. Coordination with the proposed Riverwalk improvements showed that the final configuration and appearance of the closures would likely change.

During the review of the existing levee system, potential levee improvements were identified (see Table 27). These improvements are itemized in the attached tables and drawings, feasibility study report Volume 3. Many of these improvements are only related to operational issues or are strictly utility relocations and are therefore ineligible for federal participation. These levee concerns are identified for normal City operation and maintenance activities.

The City also requested that the District investigate whether new pump stations, new pumps, new trash rack scrapers, or expedient temporary closures could be recommended and cost shared. The pump stations, pumps, and trash rack scrapers would not meet economic justification for federal involvement. However, expedient temporary closures could be cost shared because of the increased reliability provided to the whole system.

An inventory of the levee systems was prepared and the levees were drawn on the new topographic mapping. Consolidation of the system components, potential deficiencies, City and federal nomenclature, and new topographic mapping should be beneficial to the

City. The *Microstation J* format is compatible with the City's CADD capability and GIS system. In this format, the City can tailor the drawings to meet their needs.

2. Record Floods of 1993

The Floods of 1993 devastated vast floodplain regions of the Midwest with unprecedented flood levels. Left in the wake of these record floods were monumental property damages and personal suffering. One of the most catastrophic floods of 1993 occurred in July, when flooding on the Des Moines and Raccoon Rivers left a lasting impact on the citizens of the Des Moines Metropolitan area. This flood staggered the City of Des Moines with flood levels up to 6 feet higher than any previous flood-of-record on the Raccoon River, swamping the Des Moines Water Works facilities that provide municipal water to the greater Des Moines metropolitan area. A peak Raccoon River flow of 71,000 cubic feet per second (cfs) was recorded at the Fleur Drive stream gage. This flow is equivalent to a 0.5 percent (200-year) flood event. The design 1 percent chance (100-year) flow for the existing federal levees on the Raccoon River was 60,000 cfs, as shown in Figure 5.

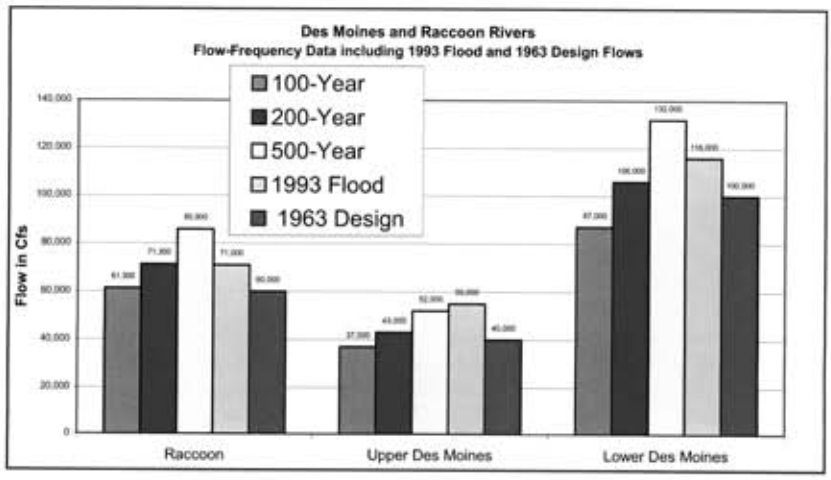

Figure 5 Flow Frequency Data

On the Des Moines River, flood levels exceeded previous 1954 record flood levels by 3 to 4 feet through the downtown reaches. These levels are even more impressive considering that the upstream U.S. Army Corps of Engineers Saylorville Lake flood control reservoir began operation in 1977 on the Des Moines River. The Des Moines River floodwaters in 1993 drove the reservoir levels to record levels, ultimately reaching an elevation of 892.0 ft., NGVD. This level exceeds the design full flood control pool elevation of 890.0 by two feet. Emergency spillway flows from the reservoir occurred throughout July. Saylorville Lake outflows were 21,000 cfs on July 8th prior to the severe

thunderstorms that occurred in central Iowa on July 9th. The cumulative flows in the Des Moines River from Saylorville, Beaver Creek and other lateral inflows resulted in the design 40,000 cfs flood levels in Des Moines being rapidly exceeded on July 10th, less than two days after the thunderstorms started. Additionally, as Saylorville Lake exceeded elevation 889.0 NGVD, outflows from the dam were increased to 42,000 cfs. A peak flow of 55,000 cfs was recorded on the Des Moines River at the 2nd Avenue stream gage above the confluence with the Raccoon River by midday on July 10th. This flow exceeds a 0.2 percent chance (500-year) flood event. Downstream of the Raccoon River at the SE 6th Street stream gage, a Des Moines River flow of 116,000 cfs was recorded. This flow falls midway between the 0.2 percent chance (500-year) and the 0.5 percent chance (200-year) flood events. As shown in Figure 5, the design 1 percent chance (100-year) flow for the existing federal levees on the Des Moines River was 40,000 cfs upstream of the Raccoon River and 100,000 cfs downstream of the Raccoon River confluence. The federal levees were operating in the freeboard range above the design flood level.

The levee systems prevented significant damage from the 1993 flooding. However, there were also significant damages due to flooding when design and operational capabilities were exceeded. Both the Central Place and Birdland levee systems failed. These levee systems were not part of the federal levee upgrade in the 1970s. The Birdland system failed July 11, 1993 when a temporary earth closure over a roadway failed. Later, both Birdland and Central Place levees were overtopped. The Des Moines Water Works levee also failed in 1993 when the levee was overtopped. Following the 1993 flood, the water works improved this system by raising and strengthening the levee. The Raccoon Levee system, Reach 6, was improved in cooperation with the federal government under Section 205 authority.

The three downtown levee systems showed mixed levels of performance. A levee system is only as good as its weakest link. The Downtown West Levee, Reach 4, failed when water entered through a railroad closure at the upstream end. In addition, there were areas where floodwater entered the interior through storm sewers due to inadequate closure at the line of protection. Following the flood, the City constructed steel closure gates over the railroad at the upstream end of the levee.

The Downtown East Levee, Reach 3, did not breach during the flood but did experience serious distress. An area of the levee between SE 6th and SE 14th Street showed severe distress. The problem was caused when a large tree tipped over and the levee began to scour very quickly around the root ball. Also, there was significant under seepage. The problems may have been compounded by the poor quality of embankment and unknown compaction standards. The levee from SE 6th to SE 9th Streets was reconstructed after the flood with a setback levee and inspection trench. After sustained high water in 2001, the existing bank was shaped and stabilized with riprap.

The Downtown South Levee, Reach 5, performed well with little signs of distress. The levee system does include several operability requirements during a flood including several levee closures, gate operation, portable pumping requirements, and levee monitoring.

Performance of the Des Moines Levees in 1993 illustrated the strength of the system, while revealing some underlying weaknesses. Many of those weaknesses have been corrected under the PL 84-99 rehabilitation authority and Section 205 authority. The City has also made improvements to the levee systems and to their operating instructions.

The three downtown systems are included in this study to identify remaining areas of weakness and to consider potential improvements. Alternatives investigated include temporary closure requirements and an analysis of levee height and embankment cross section. Also, existing levee features to include gatewells and utility closures, as well as stone protection, may require rehabilitation to ensure sufficient operability in the future. This design report includes a focus on operability requirements during a flood event. The Des Moines Levee systems are complex due to the magnitude of through penetrations, closure requirements, and pumping requirements. The total length of the levee, approximately 20 miles, can easily exceed City staff capability. Improvements that simplify operation and free City staff for other purposes would greatly improve total system reliability.

C. Hydrology and Hydraulic Studies

This study included several hydrology and hydraulic products to include updated profiles and flood plain mapping. The floodplain mapping has been digitized in *Microstation J* format and is available upon request.

An excerpt from the new profiles is attached in tabular form, Table 16. Additional detail can be found in the Appendix A, *Hydrology and Hydraulics*, of the main report.

Table 16 Comparison of River Flood Profiles and Downtown Levee Heights

DES MOINES RIVER PROFILES

HEC_RAS River Sta	Description	0.01 FREQ. (100 YEAR) W.S. Elev. (ft)	0.005 FREQ. (200 YEAR) W.S. Elev. (ft)	0.002 FREQ. (500 YEAR) W.S. Elev. (ft)	Downtown East Levee				Downtown West Levee				Downtown South Levee			
					Station	As-built top elev	Distance above 200 yr	Distance above 500 yr	Station	As-built top elev	Distance above 200 yr	Distance above 500 yr	Station	As-built top elev	Distance above 200 yr	Distance above 500 yr
DM 46654		**24.3**	**26.7**	**30.8**	8+60	32.2	5.5	1.4								
DM 46081		**24.3**	**26.7**	**30.8**	14+00	32.2	5.5	1.4								
DM 45909	I-235				14+70											
DM 45668		**24.1**	**26.5**	**30.7**	18+10	32.2	5.7	1.5								
DM 44872		**24.1**	**26.5**	**30.7**	26+15	32.2	5.7	1.5								
DM 44403.5		**22.9**	**25.5**	**30.0**		32.2	6.7	2.2								
DM 44403.45	Downtown West tie to high ground, CL Center Street Dam	**23.2**	**25.7**	**30.1**	29+25				87+60							
DM 44399		**23.4**	**25.9**	**30.2**		30.5	4.6	0.3								
DM 44214		**23.5**	**26.0**	**30.3**	31+25	30.5	4.5	0.2	89+10	31.2	5.2	0.9				
DM 43738		**23.5**	**26.0**	**30.3**	35+65	30.5	4.5	0.2	95+55	31.2	5.2	0.9				
DM 43570.5		**23.5**	**26.0**	**30.3**	37+82	30.5	4.5	0.2								
DM 43518.5	CL Grand Ave				38+04				97+25							
DM 43466.5		**23.5**	**25.9**	**30.2**	38+27	30.2	4.3	0.0								
DM 43340		**23.5**	**25.9**	**30.2**	39+70	30.2	4.3	0.0	98+86	30.2	4.3	0.0				
DM 43210		**23.4**	**25.9**	**30.1**	41+10	30.2	4.3	0.1								
DM 43166	CL East Locust Street				41+50				100+40							
DM 43122		**23.4**	**25.8**	**29.5**	41+90	30.0	4.2	0.5								
DM 42993	CL Amphitheater	**23.4**	**25.8**	**29.5**	43+15	30.0	4.2	0.5	102+15	30.0	4.2	0.5				
DM 42820	CL Walnut Street				44+60				104+00							
DM 42289	CL Court Ave				50+10	29.8			109+40							
DM 42567		**23.3**	**25.7**	**29.1**	47+10	29.8	4.1	0.7	106+52	29.8	4.1	0.7				
DM 42228		**23.3**	**25.7**	**28.9**	50+75	29.6	3.9	0.7								
DM 42084		**23.3**	**25.7**	**28.9**	52+15	29.6	3.9	0.7	111+65	29.6	3.9	0.7				

HEC_RAS River Sta	Description	0.01 FREQ. (100 YEAR) W.S. Elev. (ft)	0.005 FREQ. (200 YEAR) W.S. Elev. (ft)	0.002 FREQ. (500 YEAR) W.S. Elev. (ft)	Downtown East Levee				Downtown West Levee				Downtown South Levee			
					Station	As-built top elev	Distance above 200 yr	Distance above 500 yr	Station	As-built top elev	Distance above 200 yr	Distance above 500 yr	Station	As-built top elev	Distance above 200 yr	Distance above 500 yr
DM 41987	CL Railroad Track				53+19											
DM 41887		**23.2**	**25.4**	**28.5**	54+15	29.5	4.1	1.0	112+95	29.5	4.1	1.0				
DM 41772	Railroad Track															
DM 41629		**23.2**	**25.3**	**28.4**	56+88	29.5	4.2	1.1	115+90	29.4	4.1	1.0				
DM 41040		**23.2**	**25.3**	**28.4**	63+20	29.5	4.2	1.1	121+89	29.1	3.8	0.7				
DM 39916	At junction with STA 1296 Raccoon River	**23.1**	**25.2**	**28.3**	72+10	29.5	4.3	1.2								
DM 39522	Between SE 1st and Scott	**23.2**	**25.3**	**28.4**	75+68	29.5	4.2	1.1					32+20			
DM 39456.45	CL Scott Ave Bridge	**22.4**	**24.3**	**27.0**	76+30								31+85			
DM 39368	DS Scott Ave Bridge	**22.5**	**24.5**	**27.3**	77+15	28.5	4.0	1.2					32+70	28.5	4.0	1.2
DM 39078		**22.2**	**24.0**	**26.8**	80+10								35+20	27.5	3.5	0.7
DM 38812	CL Railroad Bridge				84+00								34+04			
DM 38671	DS railroad Bridge	**21.4**	**22.9**	**25.2**	84+20	27.7	4.8	2.5					39+30			
DM 37909		**21.2**	**22.7**	**25.0**	90+90	26.3	3.6	1.3					50+10	26.3	3.6	1.3
DM 37700	CL SE 6th Street												54+60			
DM 37657	US SE 6th	**21.4**	**22.9**	**25.2**		25.8	2.9	0.6								
DM 37337	DS SE 6th	**21.0**	**22.4**	**24.5**	96+80	25.8	3.4	1.3					55+00	25.8	3.4	1.3
DM 36300		**20.5**	**21.7**	**23.8**	110+45	25.8	4.1	2.0					65+10			
DM 35248		**20.0**	**21.2**	**23.3**	116+50	25.8	4.6	2.5					76+25	25.9	4.7	2.6
DM 35165	CL SE 14th Street												77+10			
DM 35094		**19.9**	**21.0**	**22.9**	118+00	25.8	4.8	2.9					0+35J	24.6	3.6	1.7
DM 33796		**19.4**	**20.4**	**22.5**	131+30	25.8	5.4	3.3					13+50J	24.0	3.6	1.5
DM 32420	Downtown South tie to high ground	**19.1**	**20.1**	**22.3**	149+60	25.8	5.7	3.5					31+45J	24.0	3.9	1.7
DM 29673		**17.9**	**18.5**	**20.7**	170+00	25.8	7.3	5.1								
DM 29384	Railroad															

RACCOON RIVER PROFILES

HEC_RAS River Sta	Description	0.01 FREQ. (100 YEAR) W.S. Elev. (ft)	0.005 FREQ. (200 YEAR) W.S. Elev. (ft)	0.002 FREQ. (500 YEAR) W.S. Elev. (ft)	Downtown East Levee Station	As-built top elev	Distance above 200 yr	Distance above 500 yr	Downtown West Levee Station	As-built top elev	Distance above 200 yr	Distance above 500 yr	Downtown South Levee Station	As-built top elev	Distance above 200 yr	Distance above 500 yr
DM 29366		**17.6**	**18.1**	**20.3**	0+00E	22.5	4.4	2.2								
DM 29223		**17.7**	**18.3**	**20.7**	9+48E	22.5	4.2	1.8								
DM 27836	Dean's Lake	**16.9**	**17.5**	**19.7**	15+20E	22.5	5.0	2.8								
DM 26978		**16.9**	**17.4**	**19.7**		20.0	2.6	0.3								
DM 24443		**16.0**	**16.6**	**18.7**		20.0	3.4	1.3								
DM 20870		**15.6**	**16.4**	**18.4**		22.0	5.6	3.6								
DM 20000		**15.0**	**15.8**	**17.9**		22.0	6.2	4.1								
DM 19000		**14.1**	**14.5**	**16.8**		21.0	6.5	4.2								
DM 18015		**14.1**	**14.7**	**16.9**		20.0	5.3	3.1								
DM 15070		**13.4**	**14.0**	**16.7**		20.0	6.0	3.3								
DM 10503		**12.4**	**13.3**	**15.7**		18.0	4.7	2.3								
DM 6863		**11.3**	**12.2**	**14.8**		16.0	3.8	1.2								
DM 5454		**10.2**	**10.9**	**13.3**		14.0	3.1	0.7								
DM 2990	Confluence with Fourmile Creek (East)	**9.0**	**9.8**	**12.2**		14.0	4.2	1.8								
RAC 14207	End of West Levee								-12+00	36.3						
RAC 14144		**30.6**	**32.5**	**35.2**					-11+10	36.3	3.8	1.1				
RAC 13546		**30.7**	**32.6**	**35.2**					-4+40	36.3	3.7	1.1				
RAC 13400	Fluer Drive								-1+60							
RAC 13280		**30.4**	**32.4**	**35.1**					-0+36	35.6	3.2	0.5				
RAC 11887		**29.8**	**31.9**	**34.7**					18+35	35.2	3.3	0.5				
RAC 11799.5	Low level dam	**29.8**	**31.9**	**34.7**					18+75							
RAC 11724		**29.7**	**31.9**	**34.7**					20+00	35	3.1	0.3				
Fleur Loop follows																
RAC 8989		**29.2**	**31.5**	**34.4**					29+90	34.4	2.9	0.0				
RAC 7201		**28.3**	**30.6**	**33.6**					42+90	33.8	3.2	0.2				

HEC_RAS River Sta	Description	0.01 FREQ. (100 YEAR) W.S. Elev. (ft)	0.005 FREQ. (200 YEAR) W.S. Elev. (ft)	0.002 FREQ. (500 YEAR) W.S. Elev. (ft)	Downtown East Levee Station	As-built top elev	Distance above 200 yr	Distance above 500 yr	Downtown West Levee Station	As-built top elev	Distance above 200 yr	Distance above 500 yr	Downtown South Levee Station	As-built top elev	Distance above 200 yr	Distance above 500 yr
RAC 5709		**27.8**	**30.1**	**33.1**					60+00	33.1	3.0	0.0				
RAC 5416	Railroad								62+85							
RAC 5347		**27.1**	**29.4**	**32.4**					63+85	32.4	3.0	0.0				
RAC 4214		**25.2**	**27.5**	**30.2**					71+90	32.4	4.9	2.2				
RAC 4049	SW 9th Street								75+15							
RAC 3832		**24.8**	**27.1**	**29.9**					75+60	31.3	4.2	1.4				
RAC 3420		**24.6**	**26.9**	**29.7**					79+80	31.3	4.4	1.6				
RAC 3214	0+00 Levee ties to high ground DS of bridge, SW 7th Street								83+15							
RAC 3175		**24.3**	**26.6**	**29.3**									1+60	30.8	4.2	1.5
RAC 2979		**24.2**	**26.5**	**29.3**					83+80	30.8	4.3	1.5	3+60	30.8	4.3	1.5
RAC 2035		**24.1**	**26.4**	**29.3**					92+30	30.8	4.4	1.5	13+40	30.8	4.4	1.5
RAC 1991	SW 5th St - Jackson Ave								92+75				13+96			
RAC 1937		**23.9**	**26.1**	**28.7**					93+30	29.9	3.8	1.2	14+60	29.9	3.8	1.2
RAC 1665		**23.7**	**25.9**	**28.5**					97+77	29.7	3.8	1.2	14+95	29.9	4.0	1.4
RAC 1487.5	SW 3rd Street								100+35				15+75			
RAC 1296	STA 41040 Des Moines, DS of SW 3rd Street	**23.5**	**25.8**	**28.4**					101+50	29.6	3.8	1.2	18+55			
RAC 271		**23.0**	**25.3**	**27.9**									28+80	29	3.7	1.1
RAC 118	Riverside Drive / SE 1st St												31+45			
RAC 89		**22.9**	**25.2**	**27.6**									31+80			

D. Design Considerations

1. Levee Closures

Levee closures are required when there is an opening in the levee embankment or floodwall. Examples of levee closures include gatewells and road closures. A gatewell usually consists of a swing door at the end of a storm sewer, a manhole, and a sluice gate on each pipe that discharges into the river. Road closures typically are either gated or temporary structures and close off either a railway or roadway crossing of a levee. Gated closure structures consist of steel swing gates to close the levee penetrations, while temporary structures usually require constructing a sand bag wall. Temporary sand bag walls should not exceed three feet of height.

2. Preferred Configuration

a) Utilities

Any pipe or utility that crosses through the levee should be relocated above the line of protection in order to eliminate problems that could occur if the utility ruptured during a flood or allowed flood water to flow along the utility damaging the embankment, leading to levee failure. In some situations a utility cannot be relocated. An example is a storm pipe that drains the interior to the river during low water conditions. When the river rises, the pipe would allow floodwaters to flow backward through the pipe and out the inlets on the inside. To prevent this, the pipe may be equipped with a flap gate. In addition to the flap gate, federal standards require that the pipe include a gatewell at the line of protection. A gatewell is a manhole usually constructed on the riverside of the levee. Inside the manhole is a heavy-duty sluice gate that can be closed during a flood. For an open pipe without a flap gate, the gatewell must be closed to prevent back flooding. For a pipe with a flap gate or a pipe without an opening to the river—such as a gas line or a water main—the gate needs to be closed only in an emergency when floodwaters are moving through the pipe due to a malfunction.

b) Road/Railway

Large openings in a levee system sometimes occur when a road or railway pass through the line of protection. Again the road should be relocated if possible. Sometimes it can be realigned to pass over the levee. If not, a gate is usually constructed. If the road almost passes over the levee, but is only a couple feet below the levee top, sometimes this opening is left as a temporary sandbag closure rather than constructing an expensive but seldom used gate.

c) Operability Considerations

During a flood event, the City must take several actions to "close" the system. The first step is to monitor river forecasts and weather conditions. When the river reaches a certain stage, certain gates must be closed. The higher the river gets, the greater the need becomes for closures to be made. Continuous inspection and monitoring is also important during a flood so that damaged pipes, inoperable flap gates, and other problems with the levee system must be identified early so that corrective action can take place. In addition to the levee closures, additional pumping is often required. The pumps must be set up and operated continuously. All of these actions require knowledge of the levee system and a large enough work force to accomplish the required tasks before the line of

protection is compromised. An analysis of required reaction time necessary for the City to make required closures to the downtown systems shows that the existing system could be improved. See Section 4.D.3.

3. Des Moines River Flood Warning Times

The advance flood warning times on the Des Moines River are not what would typically be expected on a 6,000+ square mile watershed. Due to river regulation provided by the upstream Saylorville Lake, typical warning times cannot be applied to the Des Moines River. The determination of advance flood warning times on the Des Moines River in Des Moines requires a thorough understanding of the Saylorville Lake regulation plan and lateral inflow characteristics below the lake.

Saylorville Dam is located only 10 miles upstream from downtown Des Moines. Hydraulic travel time on the Des Moines River from the dam to the confluence with the Raccoon River is only four hours. Thus, regulation changes in outflow from Saylorville Lake rapidly reach Des Moines, affecting some levee systems in less than three hours. Under normal operating conditions at the lake (lake elevations less than 884.0 NGVD), these regulation changes do not cause significant flood concerns as the outflows are regulated to limit downstream Des Moines River levels to non-damaging stages. The primary target is to maintain the Des Moines River levels at or below a stage of 24 feet at the SE 6th Street stream gage. However, once lake elevations exceed the 884 NGVD emergency spillway crest, downstream river level constraints are waived and a constant outflow of 21,000 cfs is maintained until the reservoir pool rises to elevation 889 NGVD. Once elevation 889 NGVD is exceeded, the spillway's pneumatic dam is lowered until a Saylorville Lake outflow of 42,000 cfs is reached at pool elevation 890 NGVD. For pool elevations exceeding 890 NGVD, uncontrolled outflow is experienced from the lake. Using the July 1993 flood as an example, at the SE 6th Street gage, the Des Moines River was at 26.2 feet (only 1 foot above flood stage) on July 8th. By the morning of July 10th, the river had risen 4 feet reaching the action elevation for making roadway closures in downtown Des Moines. By midnight, the river had risen another three feet, reaching the closure sills. By the morning of July 11th, the Des Moines River had risen another 1.5 feet to a stage of 34.4 feet. In summary, based on their O&M manual operating stages, the City had only 18 hours to make all the roadway and railroad closures on the Des Moines River levees throughout the City.

As prescribed by the regulation plan, the Corps of Engineers cannot reduce outflows from Saylorville Lake to reduce downstream flooding once the reservoir is in emergency operation above pool elevation 884 NGVD. As such, a constant 21,000 cfs is discharged to the downstream Des Moines River channel. This flow rate coupled with rapidly rising lateral inflows from Beaver Creek and numerous other urban tributaries can result in flash flood conditions on the Des Moines River through the City, potentially reducing the flood fighting response time dramatically.

E. Closure Analysis of Alternatives

A flood, such as the Great Flood of 1993, would require the City of Des Moines to make 50 road and rail closures, 34 of which are sandbag closures. The Des Moines system includes 110 gatewells. Several of the gatewells must be closed to prevent back flooding. Several temporary pumps must be installed to control interior flooding after the levee is closed. The City must also monitor and operate approximately 20 existing pump stations. The levees shown in Feasibility Report Volume 3, Sheet X2, include approximately 20 miles of levee system that must all be inspected and monitored during a flood event. These requirements could overwhelm the City flood fighting staff. Modifications to the levee system could be constructed in order to simplify the closure requirements.

The following is a list of closure alternatives and descriptions.

1. Continue to use sandbag or earth closure – no change
2. Change alignment of levee, road or bridge so that closure is not required.
3. Connect levee to bridge abutments. (Waterproof bridge railings and drains).
4. Purchase rigid plastic georgic system to be filled with sand during road closure.
5. Purchase temporary flip up barrier such as the Pallet Barrier system.
6. Construct swing gate or roller gate.
7. Construct flip-up panels that lay flat in the roadway when not in use.
8. Construct stop log panel system and storage bins.
9. Purchase water-filled barrier system.
10. Install manufactured self rising plastic barrier.

In order to analyze alternatives and to determine if improvements are cost effective, an economic analysis is performed. Determining a benefit to cost ratio for operability improvements is difficult because it requires more than a quantitative approach. The analysis shown in **Table 17** uses both qualitative and quantitative analyses.

During emergency flood operations, the City of Des Moines assigns responsibilities to the available work force, see the table below. Flood activities include:

Table 17 City Organization During Flood Emergencies

Sewer Maintenance Division	
	Operate and install portable pumps
	Close sluice gates
	Assist in manhole welling operations
	Clear debris in culverts
Street Maintenance Division	
	Fill and place sandbags
	Install earth levee closures
	Emergency levee repairs
Sidewalk Division	
	Fill and place sandbags
	Assist bridge division
Bridge Division	
	Clear logs and debris at bridges
	Aid in barricade placement
	Install levee flood gates and panel levee closures
	Emergency lighting and generators
Street Cleaning Division	
	Barricade placement
	Fill and place sandbags
	Aid in hauling materials
	Clean streets prior to opening
Forestry Division	
	Tree removal
	Records Room
	Compile flood information

The Department of Public Works prepared a flood manual dated 2001-2002 that shows an emergency flood operations staff of 132 employees for the day shift and 93 employees for the night shift. The street maintenance division is responsible for making the earth levee closures. They have assigned 12 employees per shift to this task. An additional eight employees are assigned to flood gate closures.

1. Sand Bag Closure

The required road closures are shown on Table 30. The total length of required earth closure is about 2,400 linear feet. An earthen closure if constructed with a 10 foot top width and 2H to 1V side slopes would require about 6,400 CY of soil or sand. The closure should then be covered with plastic sheeting and the plastic should be anchored with sandbags. If the closures had to be made within 18 hours notice, it would take 36 trucks and approximately 50 people. This assumes a one hour cycle time for the trucks to load, travel, dump, and return. Personnel would include a loader operator and a truck driver. At each of the 27 earth closure sites, there would be 2 people placing plastic, 2 people placing sandbags, and a third person directing the truck divers while the closure is being constructed. Attempting to accomplish this work in the required time exceeds City resources. Additional personnel and equipment would be required to safely complete the closures.

If the recommended improvements as shown on the spreadsheet were made, the total amount of closures would be reduced 60 percent. Also, additional time would be available since a majority of the closures would not have to be made at the same time. Downtown City streets would be allowed to remain open longer and the closures would be made at a higher elevation. The number of closures would be reduced from 27 to 14. This would reduce required resources to 20 trucks and 25 personnel. The reliability of making the required closures and the reliability of the closures themselves would increase. This would greatly reduce the coordination required during a flood operation and free resources for other requirements.

The reliabilities associated with closure improvements involve risk analysis and risk-based decision making concepts. These types of risk analyses are often used for determining the integrity of U.S. Army Corps of Engineers' facilities in the Major Rehabilitation program and require the knowledge of two main parameters for the systems being evaluated: their unsatisfactory performance probabilities and the consequences of unsatisfactory performance. These parameters are needed to perform the feasibility risk evaluation of systems for the purpose of planning and screening economic justification for alternatives. For some project applications, this information is not available from computational analysis or historical records are insufficient. In these applications, the **U.S. Army Corps of Engineers, Rock Island District** is increasingly turning to expert elicitation to provide the required parameters in order to complete the economic analyses for proposed improvements to a project system. An adaptation of the expert elicitation process that the **District** uses for their Major Rehabilitation projects was used to determine the required reliability parameters related to closure improvements in the downtown levee systems. The consequence values were obtained from flood damage data for the downtown levee reaches.

The expert elicitation process is defined as a heuristic (aiding in discovery or learning) process of obtaining information or answers to specific questions about certain parameters such as unsatisfactory performance of a closure structure, expected outcomes, and consequences related to the unsatisfactory performance event. Knowledgeable engineering personnel were consulted for their expert input on the reliability of the Des Moines levee closures being studied. These personnel included experienced Corps Flood Area Engineers and City engineers who were involved in the 1993 flood events in Des Moines and were familiar with the capabilities of the City's public works crews and the nature of the existing closure requirements. A consensus of these engineers was that levee closure reliabilities involved two main parameters—the probability of the public works crews being able to respond in time to make all the required closures and, if made, the reliability of the closure measures withstanding the forces related to the flood event. Both these parameters were levee closure issues during the 1993 flood events in Des Moines that caused significant flooding. A total probability of the levee system closures was determined to be the multiple of these two probabilities. These expert engineers considered many factors; advance warning times, number of closures, measures required to make closure, height and width of closures, location of closures, etc. in arriving at the reliability values contained in Table 18.

Table 18 Levee Closure Reliability

	Existing			Alternative		
	Making	Reliable	Tot. rob	Making	Reliable	Tot. rob
Reach 3	0.40	0.70	0.28	0.90	0.90	0.81
Reach 4	0.50	0.70	0.35	0.90	0.95	0.86
Reach 5	0.80	0.80	0.64	0.95	0.95	0.90
Composite	0.57	0.73	0.42	0.92	0.93	0.86

Probability of Making Reliable Closures:

1. Each Reach considered as one closure system.
2. Probability of the City "Making" a response to the closure corresponds to the City's availability of manpower, materials other emergency responsibilities, and flood warning times before closure sill overtops.
3. Probability of the City making a reliable closure provided a "making" response has occurred. i.e. Just "making" the closure is no good if the closure subsequently fails once floodwaters exert hydraulic forces, considering type of closure, construction materials used, climatic conditions, and availability of time.
4. Total probability of making reliable closures = (Probability of Making) X (Probability of Reliable)
5. Composite Downtown System Probabilities = Probability of Making:(Reach 3 + 4 + 5)/3 X Probability of Reliable:(Reach 3 + 4 + 5)/3

2. Description of Potential Temporary Closure Alternatives

There are several methods to make levee closures. A temporary closure is often used to close a small opening in a levee system within the top three feet. A deeper opening usually is made with a gated structure. Gate structures are usually much quicker to close, more reliable after they are closed, and use less manpower. Levee systems incorporate temporary closures when they are seldom needed and when it is expensive to construct and maintain a gated closure. Many times a temporary closure is made from sandbags. A sandbag closure is usually labor intensive and time consuming. The City of Des Moines makes several of its temporary closures by installing temporary earth plugs. Each earth plug is usually covered with plastic sheeting and anchored with sandbags. In 1993, a 6-foot-deep earth closure near 6th Avenue in the Birdland Park Levee System failed, causing the interior to flood. This section of the report includes alternatives to consider when making temporary levee system closures.

a) Sand Filled Geogrid System

The U.S. Army Corps of Engineers, Engineer Research and Development Center, tested a proprietary system used to make a temporary closure. It consists of a plastic geogrid. The eight- inch high grid is opened and stretched across the opening. The grids are stacked on top of each other to the desired height, 6 feet maximum. Sand is dumped into the openings to stabilize the structure. The geogrid structure stabilizes the sand and resists water damage to the closure. It is much quicker to install than a sandbag closure and would provide a greater degree of reliability. Unlike earth fill, sand is an "all-weather" material that can easily be placed in the rain. The cost of this system is approximately $165 per linear foot for a 4-foot-high piece. More information can be obtained from Geocell Systems, Inc. http://www.geocellsystems.com or U.S. Army Corps of Engineers, Engineer Research and Development Center report, Testing and Evaluation of a New Expedient Structure for Flood Fighting – Rapidly Deployed Fortification Wall (RDFW), George F. Turk, March 2001.

b) Pallet Barrier

Another proprietary system that is gaining in popularity is a system called Pallet Barrier. It consists of a braced structure that supports an ordinary wood pallet. A rubber membrane is placed along the riverside of the structure. This structure can be placed about 3-feet high. A 5-foot-high structure would require custom made pallets and additional bracing supports. The cost of the 3-foot-high system is approximately $45 per linear foot. Additional information can be obtained at the following web site: http://www.palletbarrier.com

c) Aqua Barrier

Some flood protection districts have used water filled bladders as temporary levee closures. The bladders have an internal baffle that keeps the barrier from rolling. The advantage of a bladder is that it can be easily transported, filled with a portable water pump, and removed when it is no longer needed. The bladder would conform to the ground contours limited by the size of the bladder. A bladder system would cost approximately $100 per linear foot. Additional information can be obtained at the following web site: http://www.aquabarrier.com/index.html

d) HESCO

Another expedient method to prepare a closure is "HESCO Concertainer" containment system. It consists of coated welded wire mesh panels with coil hinges and a geotextile lining that open to form containers. Sand is placed into the containers to form the closure structure. This system was developed and is produced by HESCO Bastion USA LLC, 47152 Conrad E. Anderson Drive, Hammond, LA 70401. This system can be seen on the web at www.hesco-usa.com. The system comes in different sizes. The 3-foot by 3-foot by 15-foot-long system is a stock size that would work for the Des Moines Closure structures. The advantage of this is that it contains the required amount of sand for the closure and is not prone to erosion. The system is reusable. The approximate cost for this system is $25 per linear foot, not including the sand.

Barriers can also be fabricated from concrete or water-filled road barriers. Sills in the road and sidewalks could be constructed to receive such flood barriers in order to help anchor the barrier and keep it from sliding.

Other possible closures include swing gates, roller gates, panel closures, etc. Openings and sills can be installed to receive standard size gates or barriers. The permanent gate closures are not recommended due to the high initial cost and the high maintenance and upkeep. Constructing sills in the roadways and sidewalks tend to be difficult to maintain and to keep operational. There is usually a lot of wear and tear due to traffic, snow, ice, road salts, re-paving, debris, etc.

The City investigated two expedient proprietary systems that could improve closure times and minimize manpower requirements. The City scheduled a demonstration March 26, 2003 between the Geocell Systems, Inc. and the Pallet Barrier system. The two companies provided an indoor presentation, followed by a field demonstration at the

panel closure location on River Drive. The City of Des Moines staff found the pallet barrier system was easy to install and to remove.

Following the demonstration, the City purchased Pallet Barrier System components for use at selected locations.

3. Recommended Temporary Closure System

Lack of time, manpower, and funding are concerns for the City when trying to make several closures while the water is rising on its terms. Permanent closure improvements are the best alternatives to solve these problems. Permanent closure recommendations for this study are described in section 4.F. Where permanent closures are not feasible due to site geometry, high cost, or other factors, it is important to provide effective temporary closures in order to maintain system reliability. A rapidly deployable system that requires less manpower and is more reliable is worthwhile and is recommended for implementation.

The Rock Island District has a long history of flood fighting techniques and expertise. During every significant flood event, the District sends out teams to provide technical assistance and offer sand bags and pumps to public agencies when they have exhausted their own resources. Expedient closures have been made with several different methods to include sandbags, earth closures, sand closures, batter board fences, etc. The District does not currently maintain proprietary systems on hand and has limited experience with them. The Corps of Engineers has tested some of these systems and they have been used in both flood fighting and other uses. Clearly, the geocell and the HESCO containment system would provide a reliable closure if filled with sand. The City likes the ease of use and long history that the Pallet Barrier System presented in March 2003.

The purchase of the Pallet Barrier System is likely to result in making all the closures in time, thus avoiding a disaster. This assumes that the system could be installed more quickly and using less manpower than the existing method of either filling sand bags or building earth closures covered with plastic. Another assumption is that all the materials are on hand, and the City work force knows how to construct the system so that it is flood worthy. This would require that the plastic membrane is properly anchored and sealed, the braces, pallets or ¾ inch plywood are on hand, sand bags are on hand and filled to provide required seals, the clips are on hand, the braces do not slide on the existing pavement, the edges fit between structures and are properly sealed, and, following construction, the barriers are not tipped over or hit by moving vehicles. A recommendation is to set up the expedient barrier as part of flood preparations training and test it by building a double barrier and filling the interior space with water. During an actual flood event, once the barriers are in place and time permits, the barriers can be reinforced with sandbags.

F. Description of Road and Railroad Closure Improvements

1. Reach-3, Downtown East Measures

At Sta 11+60, construct the upstream end of the levee so that it ties into the I-235 embankment (Figure 6). Currently, the upstream end of the levee blends into high ground north of the interstate in front of the Botanical Center. The Botanical Center has upgraded the appearance of the levee by developing pedestrian areas, walkways, plantings, and other amenities. In this area the road adjacent to the levee (landside) includes catch basins that are connected to the river. The storm drains do not currently include gatewells for positive closure. Therefore, this area would require a road closure or storm drain closures during a high-level flood event. This area can be excluded from the official levee system by closing the levee south of the interstate by connecting the levee to the I-235 embankment. This would greatly simplify operating the system during flood events and avoid the necessity of upgrading the levee system north of the interstate. (Recommended)

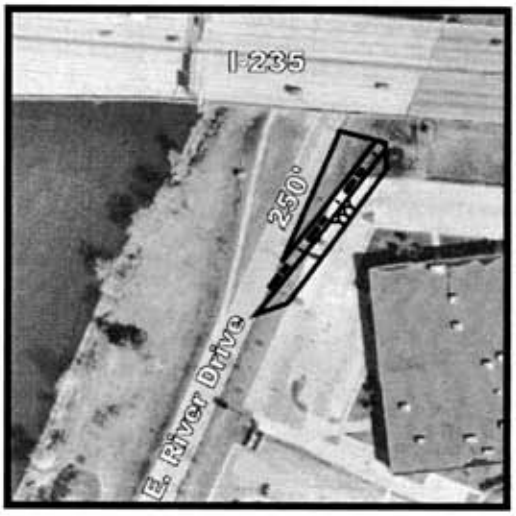

Figure 6 Reach 3, Permanent Closure, Tie Upper end of Levee into I-235 embankment

Amphitheater sidewalks Figure 12. There are two sidewalk closures in the amphitheater system that require sandbag closures. These openings could be simplified and made more reliable by constructing slots in the adjacent posts for wood boards. This would speed closure and make the closure more reliable by providing a more positive seal that is less susceptible to vandalism. Sandbags and plastic would still be required to reinforce the closure. Another alternative for these closures would be to construct a decorative gate that could be closed during a flood event. This would be the most efficient and the easiest to operate. Improving the two sidewalk closures with either stop log slots or decorative floodgates is recommended. (Recommended)

The first railroad bridge south of Court Street is inactive, Figure 7. Recommend eliminating closure. The Riverwalk Project is upgrading this bridge and plans include raising the deck to eliminate the DM 85 closure structure

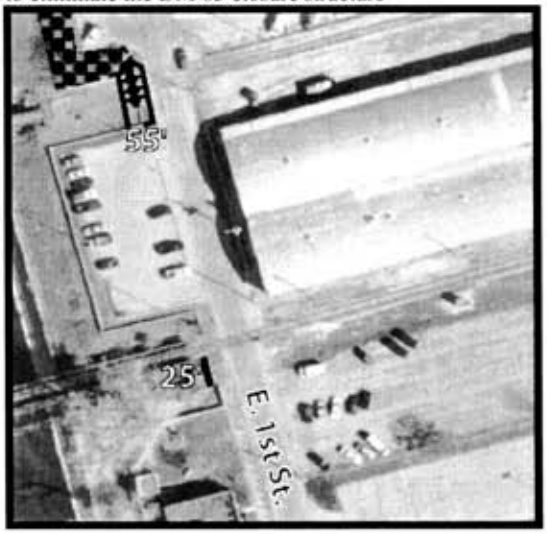

Figure 7 Reach 3, Permanent Closure, DM-85-R.R. and Reduce Closure DM-87-R.R.

Railroad, 2nd railroad south of Court Ave, see Figure 7. This is an active railroad and includes 1 track. This used to be a double track. This opening could be reduced in size by extending the floodwall closer to the track. This would reduce the amount of sand bags or earth embankment needed to make the closure. (Recommended)

Grand Avenue to Court Ave, see Figure 8 through Figure 10. There are 4 main bridges in the downtown area. The roads pass through the line of protection rather than over the line of protection. In 1993, the downtown road system had to be closed in order to make temporary earth closures. It would be very costly to raise the existing bridges and roads to pass over the line of protection. However, it would be relatively inexpensive to tie the existing levees or floodwalls into the existing bridge abutments. A flexible rubber seal could be designed to tie floodwall extensions into the bridge abutments so that the 2 structures could move independently. This would have eliminated the need to make closures in 1993 and the roadways could have remained open. However, a very high flood would still require the bridge openings to be closed. This closure would be narrower than the existing closures and the sill would be higher making the closure height smaller. The City has investigated more rapid closure systems. The Pallet Barrier system is a product that would make these closures more expedient and easier to install and remove. Most of the downtown road closures would be improved if the Riverwalk pedestrian loop and multipurpose trail is constructed. The attached drawings are concept designs that could be modified to allow follow-on construction of the Riverwalk. (Recommended)

Locust Street East, Walnut Street East, and the Amphitheater, Figure 9. Closures for Locust and Walnut can be made as described above but only if the amphitheater is modified. The existing closure is made by installing a sand bag or earth closure from the end of the levee, across the road, to the landside opening of the first pedestrian opening. If the levee is tied to the bridge abutment, the amphitheater would also have to be tied to the bridge abutment. This could be accomplished as follows: On the north side of the amphitheater, there is an existing 5 inch gap between the end of the existing bridge abutment and the beginning of the amphitheater wall. There is a 19-foot section of electrical panels boxes on top of a concrete wall. The panel boxes were not designed as a floodwall. The panel boxes could be reinforced or a wall extension constructed to the top of the electrical panels. Following the electrical boxes is a 7 foot 5 inch gap currently blocked with shrubs. To make this water tight, the opening would have to be closed with a solid wall. The shrubs could remain outside of the wall. This work would effectively tie the amphitheater to the bridge abutment. This would leave an 11-foot 5- inch pedestrian opening that could be closed more efficiently by cutting slots into the posts or constructing a decorative gate that is more easily closed. The south side of the amphitheater is similar to the north side except that the electrical panel length is 21 feet 8 inches and the gap to the first pedestrian opening is 15feet 4 inches, rather than 7 feet 5 inches. This recommendation, if implemented would minimize the closure requirements by making the opening as small as possible without raising the road and bridge. (Recommended)

Figure 8 Reach 4, Reduce Closure, DM76-Grand Avenue

Figure 9 Reach 4, Reduce Closure, DM-78 and DM-80

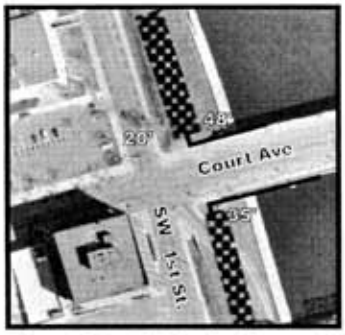

Figure 10 Reach 4, Reduce Closure, DM-82-Court Ave.

Figure 11 Reach 3, Reduce Closure, DM-73-Grand Avenue

Figure 12 Reach 3, DM-75-Locust Street, DM-77-Amphitheater, and DM-79

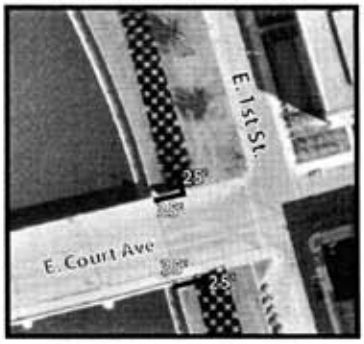

Figure 13 Reach 3, Reduce Closure, DM-81-Court Avenue

Railroad Closure at Des Moines Asphalt, Sta 170+00, Closure number 45, Figure 14. The existing closure is made by using construction equipment to move stockpiled earth into the existing gap over the railroad tracks. This opening could be reduced in size to simplify the closure. The permanent levee could be constructed closer the tracks.

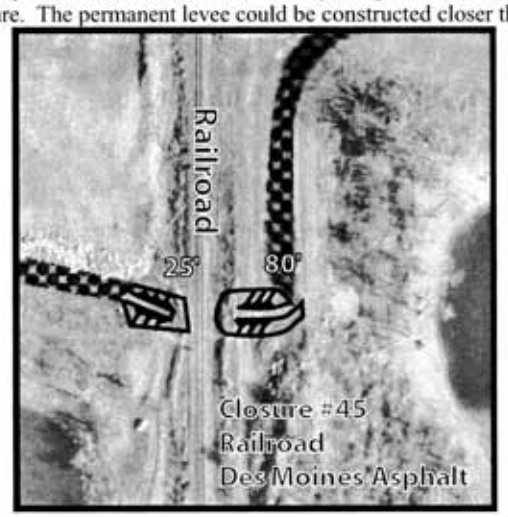

Figure 14 Reach 3, Reduce Closure, DM-45-R.R. Bridge

Railroad Bridge Bike Trail at SE 4th and Shaw, Station 83+80, Closure number 41, Figure 15. This closure should be made permanent since the railroad is no longer in operation. (Recommended)

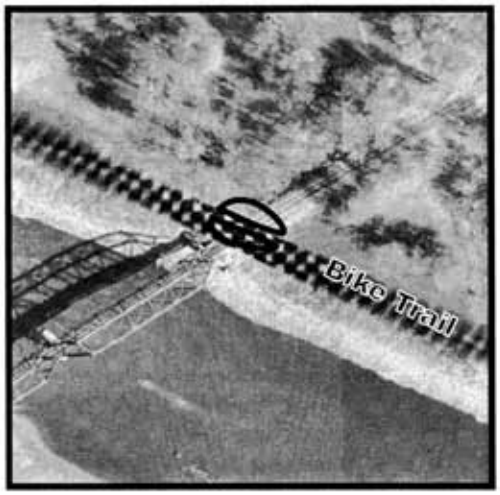

Figure 15 Reach 3, Permanent Closure, DM-41-R.R. Bridge

Carlisle Road South of Vandalia, Figure 16. This closure is near the end of the City levee. The road that passes through the levee is an existing gravel road. The road should be ramped over the levee to eliminate the need for this closure. There are no apparent reasons why the road could not be ramped up to meet the top of the levee system. (Recommended)

Figure 16 Reach 3, Permanent Closure, DM-51 near wastewater treatment plant

2. Reach-4 Downtown West Measures

The first railroad bridge south of Court Ave, Figure 17, is inactive. The closure structure could be eliminated. It is a Principal Riverwalk task to develop, design, and construct the elimination of this DM 86 closure structure.

Railroad, 2nd railroad south of Court Ave, Figure 17. This is an active railroad and includes 1 track. This used to be a double track. This opening could be reduced in size by extending the levee and/or floodwall closer to the track. This would reduce the amount of sand bags or earth embankment needed to make the closure. (Recommended)

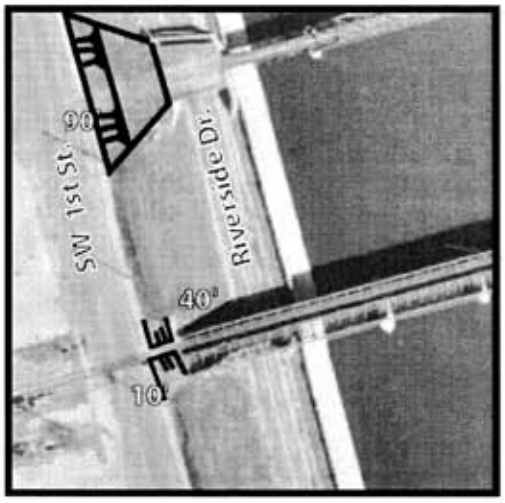

Figure 17 Reach 4, Permanent Closure, DM-86-R.R. and Reduce Closure, DM-88-R.R. Bridge

Grand Avenue to Court Ave. See discussion above in Reach 3 and Figure 11 through Figure 13. (Recommended)

SW 1st Street south of Elm Street. This closure could be eliminated by raising SW First Street above the levee. This would be fairly expensive due to the length of road that would have to be replaced to include curb, gutter, and sidewalks. This portion of the road is adjacent to a refurbished historical structure. Gatewell I is located in the middle of the street. The gatewell would have to be raised to meet the new street elevation. Not recommended due to high cost. (Not Recommended)

Sec Taylor Parking Lot at SW 2nd Street. There are currently 3 driveways cut into the levee surrounding the Sec Taylor Parking Lot. Closures 31 and 27 could be eliminated by raising the driveways to the top of the levee. This would require raising a portion of the asphalt driveways, a section of curb and gutter, and a portion of sidewalk if applicable. The disadvantage to raising these driveways is that visibility from the parking lot to the street would be obstructed until the entering or existing vehicle arrived at the top of the levee. Not recommended due to site distance between street and parking lot. (Not Recommended)

The middle driveway is closure number 29. Raising this entrance would disrupt the entrance to the stadium. Improvements to minimize this closure are not recommended at this time. (Not Recommended)

Railroad Upstream of SW 9th Street. There is an existing swing gate at this location. The railroad is no longer in service. The gate could be removed and a permanent closure constructed in its place. Not recommended due to future development plans. (Not Recommended)

The upstream end of the existing levee system includes railroad closure gates. There are no recommended improvements for this area. The gates provide a quick, reliable way to close off the railroad opening. (Not Recommended)

3. Reach-5, Downtown South Measures

Railroad Bridge at SE 1st Street and VanBuren, Station 34+04, Figure 18, closure number 42. This railroad is no longer in service. A permanent closure should be made at this location. (Recommended)

Figure 18 Reach 5, Permanent Closure, DM-42-SE 1st Street

Railroad Bridge east of SW 7th Street, Station 0+00, Figure 19, closure number 36. This railroad is no longer in service. A permanent closure should be made at this location. (Recommended)

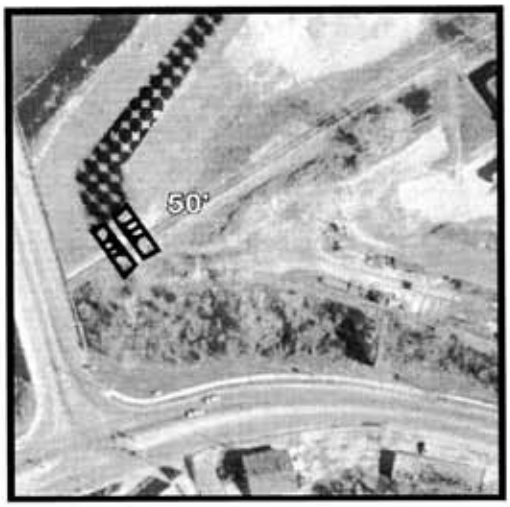

Figure 19 Reach 5, Permanent Closure, DM-36-R.R. SW 7th Street

4. Levee Height

The downtown levee systems were constructed to withstand the 100-year flood event. The 1993 floods exceeded these levels. Due to the significance of the protected area and the metropolitan downtown district of Des Moines, higher levels of protection may be appropriate. As part of this study, the U.S. Army Corps of Engineers analyzed the economic justification of raising the levees to protect against higher flood events. Costs are presented in the "Cost" paragraph below. The economic analysis determined a lack of justification to raise levee heights in the downtown systems. See Appendix B for the economic analysis.

The current levee heights, taken from as-built construction drawings, were compared to the new flood profiles. An extract of the profiles and the comparison to locations along the levee alignment is shown in the attached Table D-6. Generally the levees provide protection up to the 200-year flood event. In most locations the levees are at least 1 foot above the 500-year profile line. This would not provide sufficient freeboard to protect against a 500-year event, but it is a logical level of protection. The levee segments that do not meet this level are generally located in the immediate downtown area and along the left bank (north bank) of the Raccoon River. When major rehabilitation or modifications to the levees occur, the City should ensure the levees are rebuilt to at least 1 ft above the 500-year profile line. See the Hydrology and Hydraulics Appendix for more detailed flood profile descriptions.

5. Levee Embankment, Floodwalls, and Riprap

When the downtown levees were reconstructed in the 70's, the embankment included an inspection trench and compacted impervious material. The inspection trench verifies that the levee foundation is made of impervious levee material, is well compacted, and

contains no unknown utilities or materials. Once the levee and its embankment are properly constructed and maintained, it should provide lasting performance. Therefore, to improve this levee or increase levee height, the inspection trench and embankment reconstruction is not required. To increase the height or cross section, the grass on the levee would be stripped off, the levee would be scarified and new levee material compacted in horizontal lifts to the new cross section.

Some areas of the levee have steep side slopes or low spots. These areas would be recommended for improvement in all 3 alternatives. Areas that were not included in the original levee upgrade would be assessed and improved if required. A suspect area is in the Downtown East levee reach between SE 9th and SE14th. The levee between SE 6th and SE 9th was rebuilt to federal levee standards after the levee suffered serious damage during the 1993 flood. Between SE 9th and SE 14th the levee was not reconstructed but only reinforced with a sand drainage blanket for severe under seepage. The cross section of this section of levee is lower than adjacent levee and has substandard side slopes and top width. Reconstructing this section of levee would facilitate maintenance mowing and improve levee reliability. This would take about 4,000 CY of compacted levee embankment. This section of levee is shown on drawing sheet number DMR3-6.

Existing floodwalls were analyzed to determine what effort was required to raise the top of the floodwall. In some cases, the wall had the capacity to withstand higher flood elevations. Other walls required the wall and foundation to be thickened.

The downtown levee systems generally consist of a concrete river wall or riprap reinforcement along the lower half of the levee. This works well. The lower portion of the levee is consistently in contact with the river. The lower slope of the levee is inundated more frequently than the upper slope of the levee. Grass is well established above the riprap or river wall. The grass is relatively easy to maintain. Riprap requires periodic spraying to kill any growth of "woody" vegetation. The riprap that was placed in the 70's is beginning to deteriorate and should be reinforced with new riprap.

The existing river walls are very old and again beginning to show signs of distress. However, at this time no new replacements are anticipated. During flood inspections, the river wall condition is noted. If it appears that damage to a river wall could potentially lead to levee failure, the wall should be repaired. To date, the river walls do not present a significant danger to the levee system.

6. Gatewells, Pump Stations, and Utilities

Gatewells and associated utilities usually consist of concrete reinforced pipe (RCP) with a reinforced concrete manhole that houses the sluice gate, stem, brackets, access hatch, and operator. The existing gatewells were inventoried and annotated on the levee plan drawings. During a project site investigation, some of the gatewells were opened, but most were only inventoried. Original gatewells were constructed between 1967 and 1972. The City has an active maintenance program to replace gates or operating machinery when necessary. The City has abandoned several of the original gates and has constructed several new gates. All gates are shown on the drawings and are listed in the attached Table 20.

Several of the existing gatewells in the downtown levee system are in poor condition. Problems include CMP pipes with flap gate protection only. All 3 levees exhibit this problem. Many times flap gates are desirable; however, flap gates can easily malfunction and should have a sluice gate for positive control at the line of protection.

One gatewell configuration at SE 9th Street pump station includes a force main that enters the gatewell at the riverside of the gate. If this pipe broke on the landside of the levee, it would be difficult to close the pipe and prevent flooding.

The as-built construction drawings show several smaller pipes that penetrate the levee system with only flap gate protection or no protection at all. Some of these pipes were identified during the site inspection. All of these pipes should be identified to ensure they have been properly removed or that they are modified to provide positive closure.

During original construction, some levee penetrations were properly configured, but the pipe materials were either CMP or VIT pipe. Both of these materials are not as durable as RCP and the condition of these levee penetrations is in question. The City should thoroughly inspect these pipes and replace them with new pipe when required.

The City of Des Moines has trunk sewer lines and a storm sewer interceptor that generally parallels the levees toward the sewage treatment plant. Portions of the sewer line are located under or adjacent to the levee and floodwall systems. Some of these lines are 78 inch in diameter. These lines have been shown on the drawings. The cost to relocate the sewer lines or the levee is very high and probably impracticable. If these pipes ever become damaged, the levee could erode into the pipes, resulting in a loss of levee section and levee failure. This would become obvious during a flood, but could be masked when the river is low. For these reasons, the existing sewer lines do present a significant threat to the levee system. The only practical way to ensure this does not become a problem is to routinely inspect the sewer lines (usually a remote camera inspection) and then give top priority to repairing any damage that could occur. Some thought could also be given to the emergency action plan to try and repair levee damage during a flood. This would require isolating the sewer lines to stop any flow in the line and then filling the sinkhole in the levee system.

There are several water mains that cross the levees and some that are located adjacent and parallel to the levees. These are also a potential threat to the levee system. A water main break near the levee could erode away levee material very quickly. Some of these water mains are under significant pressure and are very large, i.e. 30 to 48 inch diameter. As a water main ages, it is more susceptible to breakage. During a flood, the levees are placed under a significant water load. In addition the ground and the levees can become saturated. The wet soils lose strength. If a break in a water main occurs, it can occur during a flood event, or the worse possible time. To prevent this, water mains should not be located near the levee. For mains that cross the levee, the lines should be constructed over the line of protection (in the freeboard section of the levee). The levee should be overbuilt to provide additional stability and to provide sufficient cover to keep the water

mains from freezing. Older water mains should be reconstructed in order to provide reliable service and minimize the risk to the levee systems. All water main crossings should be identified and inventoried with as-built construction details. Substandard penetrations should be rebuilt to comply with U.S. Army Corps of Engineers guidelines.

Other utilities such as fiber optic lines, gas lines, buried electric lines can also threaten levee integrity. Many times these utilities are constructed without permits. If the lines are trenched through the levee, many times the backfill is not compacted. This loose soil is a significant danger to the levee since water can easily saturate the uncompacted soil and lead to piping along the utility. This can rapidly erode the levee and lead to levee failure. All utility crossings should be identified and placed on the drawings. Utilities should pass through the upper potion of the levees. If a utility was not installed correctly, it should be removed.

The City of Des Moines has an active program to upgrade, maintain, and operate Pump Stations. The existing pump station capacity in the downtown area is sufficient with a couple exceptions. The City would like to construct 2 new pump stations. The downtown south levee system was constructed with a storage basin or ponding area located near SE 14th Street, see sheet DMR5-3 and DMR5-4. When there is a flood event, the City closes the gate at the levee and water is allowed to collect in the ponding area. The City has to position large portable pumps in this area. Construction of a pump station in this area would greatly assist the City by reducing operating requirements during a flood event. Unfortunately, due to the infrequent use of a proposed pump station, the benefits of constructing this pump station are less than the costs and therefore, there is insufficient federal interest to recommend this work as part of this study.

The City would also like to construct a permanent pump station in the downtown east levee near Dean's Lake, see gatewell 351 A&B sheet DMR3-8. The reason is the same as above. It would greatly assist the City in reducing operating requirements during a flood event. Again there appears to be insufficient benefits to justify the cost of construction.

7. Operation and Maintenance

Operation and maintenance activities are a primary factor in establishing the need for system improvements. Since the Des Moines system has been in operation for a relatively long period of time and has also recently been through a recent flood of record in 1993, City personnel are familiar with operating and maintenance requirements. An upgraded or modified project would be designed to minimize operational and maintenance requirements. Of primary concern is reducing the effort and time it takes to make closures prior to a major flood event. Replacing worn out gates and operating mechanisms would lower future maintenance costs. If report recommendations are approved and implemented, plans and specifications should include improvements to "maintenance heavy" components of the levee system in order to lessen operation and maintenance requirements.

8. Permits

Recommended repairs within the downtown levee systems should not require:

- State Flood Plain permit
- Section 401 of the Clean Water Act (Water Quality)
- Section 402 National Pollution Discharge Elimination System (NPDES)
- Section 404 (Dredged or Fill Placement in Waters of the US)

However, this feasibility study is coordinated with several public agencies that make a determination on what would be required for the work described herein. Permits to perform rehabilitation of gatewells and gates, utilities, or pump stations are not required. Embankment repair that does not encroach on a wetland or toward the river flow area does not require a permit unless it disturbs an area greater than 1 acre. In this case, a NPDES permit would be required and is obtained from the Iowa Department of Natural Resources. The contractor may be required to obtain local permits that are not listed herein.

9. Cost

A primary purpose of this feasibility study is to develop cost effective recommendations to improve or upgrade the downtown levee systems. Costs to rehabilitate or repair existing levee features are not authorized within the framework of this study and are not recommended. Features that would improve the levee system or system operability that appear to be cost prohibitive include the 2 new pump stations; flattening existing landside levee slopes between East Elm and Scott Ave, Reach 3; and relocating large sewer lines adjacent to existing levees. Rehabilitation or repair features that are a City responsibility include placing new riprap protection, replacing gatewells and associated piping, monitoring and repairing aging utilities that could adversely affect the levees.

10. Real Estate

Small parcels of real estate may be required to implement the recommended alternatives for the downtown systems. However, most of the recommended alternatives are located on existing levee right of way or existing City property.

11. Coordination

Close coordination was maintained with the City during preparation of this study. Discussions with City personnel who operate and maintain the system as well as the City engineering department have provided valuable information to the project design. A public meeting was held to incorporate views of citizens into the design. A review of operational requirements and existing system performance were analyzed to develop a project that optimizes performance and simplifies operation. Project reviews would afford additional opportunities for the City as well as the public to coordinate their views with the Corps of Engineers for potential improvements to the designed system.

12. Recreational Opportunities

The City of Des Moines and other development and action groups have pursued recreational opportunities along the Des Moines and Raccoon Riverfronts. The Corps of Engineers cost shared a Greenbelt project, the downtown amphitheatre, in 1995, as an example. The City has an extensive multi-purpose trail system. Much of the trail follows levees and the rivers connecting to other federal trails along the rivers and reservoirs. The City recently received a grant from the Principal Financial Group to develop the riverfront along the Des Moines River in the downtown area. The new riverfront would include a signature pedestrian bridge visible from the interstate and an upgraded 1.2 mile riverwalk loop. The downtown levee system can be modified to serve both the flood control functions and enhanced riverfront recreational purposes.

G. HTRW

A Phase I investigation revealed recognized environmental conditions in the Downtown levee locations, due to the historical uses of the property. A Phase IIA investigation was performed in selected areas along the levee alignment to determine HTRW liability and associated costs. These conditions were confirmed via Phase IIA sampling, revealing metals and PAH concentrations in excess of the Iowa State Land Recycling Program Standards. Per ER 1165-2-132, contaminated land should be avoided if at all possible. However, avoidance is not a feasible option for this project. Instead, the District recommends that the City enter into the Iowa Land Recycling Program (LRP). The result of this program is a certificate of No Further Remedial Action Planned (NFRAP). It is the State's policy that a NFRAP certificate meets the requirements of remediation, therefore, a plot of land with a NFRAP certificate is viewed the same as a parcel without any previous contamination. It should be noted that certificates could be voided by additional, post-issuance contamination.

ER 1165-2-132 states clearly that construction shall not be undertaken until the sponsor, at the sponsor's expense, completes all remedial actions. Therefore, in light of the contamination identified at the Downtown project locations, construction shall not proceed until a NFRAP certificate is obtained.

Prior to submission of the feasibility report, the sponsor must supply the Corps with a letter of intent, accepting responsibility for the remediation and outlining the steps that will be taken to secure a NFRAP certificate. If this certificate is obtained prior to the submission of the feasibility report, it will be included in the HTRW Appendix. Once a project site is deemed remediated, construction may proceed.

See Appendix E of the main report for the complete HTRW analysis and results.

H. Alternatives

This feasibility study includes alternatives to upgrade the existing levee system and to raise the existing levee heights. Recommended improvements have been addressed in the preceding text and are shown in the attached
Table 27. Alternatives to raise the height of the existing levees to increase performance are discussed below.

The existing levees were designed to provide protection for a flood with a recurrence probability of 0.01 or 1 percent. This has been referred to as a 100-year flood; however, the U.S. Army Corps of Engineers now uses a risk-based analysis to compare levee height to a design flood. When the new flood profiles were compared to the existing levee heights, the analysis shows that the existing levees do provide adequate protection for the 0.01 event. The levees are very close to providing protection for the 0.005 event, the 200-year flood. The levees do not provide 95 percent probability of withstanding a flood with a recurrence interval of 0.002, the 500-year event. Table 16 is an excerpt from the flood profiles comparing the flood profile to the existing levee heights. The downtown levees are generally 1 foot higher than the 500-year profile line. The as-built levee top elevations dip below this elevation at locations in downtown Des Moines. Whenever the City pursues work in or around the levee systems, it should ensure that levee height is at least 1 foot above the 500-year profile line. Where the levee exceeds this elevation, the levee would provide additional freeboard during a flood event. The additional levee height provides a greater factor of safety and makes flood fighting easier.

The 1963 Design Memo listed the 1 percent chance event as the design discharge. For the upper Des Moines River (above the Raccoon River) this was 40,000 cfs, and for the lower Des Moines River it was 100,000 cfs. The levees were built 3 feet above the 1 percent event. In 2004 the 1 percent flood event was recomputed using the longer record. The discharges were now 37,000 cfs above and 87,000 cfs below the junction with the Raccoon River.

Table 19 shows approximate costs for the three levee height alternatives. The 0.002 event (500 year) requires significant levee fill and additional real estate acquisition.

I. Value Engineering

A formal Value Engineering (VE) report will not be conducted for these three downtown reaches. This part of the project will not exceed the $2 million dollar threshold which requires a VE report.

Table 19 Cost Estimates Levee Raise to 500-Year

The following table includes a cost estimate for raising each of the levee systems to the 0.002 frequency of 500-year flood event.

0.002 Frequency, Levee Raise	Reach 3	Reach 4	Reach 5
Levee Feature	Estimated Cost	Estimated Cost	Estimated Cost
Earthwork	$2,100,000	$1,500,000	$1,200,000
Floodwalls	1,250,000	1,900,000	100,000
Stone Protection	350,000	650,000	100,000
Gatewells	2,500,000	2,900,000	1,400,000
Closure structures	750,000	1,650,000	1,200,000
Contingencies	1,700,000	2,100,000	1,000,000
Planning, engineering, and design	1,750,000	2,200,000	1,000,000
Construction Management	1,000,000	1,300,000	600,000
Real Estate	Not estimated at this time	Not estimated at this time	Not estimated at this time
Total:	$11,400,000	$14,200,000	$6,600,000

A summary of recommended closure improvements is shown in Appendix D, Cost Engineering.

J. City of Des Moines Downtown Levee System Assessment

August 21 and 22, 2002
Field Site Visit/Trip Report

Inspectors: Dean Cerny, project engineer; Tom Heinold, flood area engineer;
John Payne, City public works

The inspectors worked from 1000 to 1800 on August 21, and from 0700 to 1800 on Aug 22 inspecting the three downtown systems . John Payne, representing the City, was present for most of the inspection. Other City personnel assisted in answering questions about underground utility layout.

1. In several locations there were CMP through pipes protected with flap gates only. There were also floodwall penetrations with flap gate protection only.

2. Riprap protection near the waterline in several locations was beginning to deteriorate and should be upgraded.

3. The City is very interested in simplifying flood operations. Several closures can be simplified or eliminated completely. It appears that several of the downtown road closures can be simplified by connecting the levee to the bridge abutments. In 1993, the river flowed around the abutments adjacent to the temporary closures, disrupting traffic. The construction of the amphitheater will make levee closures more difficult. The existing opening could be modified to simplify the closure requirements by sealing the gap between the electrical panels and the bridge abutments and connecting them to the first post. The electrical panels would have to be modified as a floodwall. The four pedestrian gaps between the posts could be simplified by cutting stop log slots into the posts.

4. The City has to install Crissafulli pumps in the ponding area in the Downtown south system. The City would also like to construct a new pump station in this area.

5. Some of the gatewells were incorrectly numbered. This could cause a problem during flood fighting. Some of the confusion appears to be the addition of new gatewells.

6. Some gatewells are located 6 to 10 ft away from the floodwall on the riverside of the wall. This leaves the section of pipe between the gatewell and the floodwall unprotected.

7. A few levee areas should be reinforced with additional fill.

8. A few areas within the rivers have silted in; the sediment should probably be removed. This work may be too expensive for the City to do as regular O&M.

9. Portions of the Redrock remedial works levee were in poor condition due to growth in riprap areas and erosion of foreshore where the riprap is being displaced or no riprap exists. One of these areas along the Des Moines is scheduled for re-build.

10. The City pump station manager, Joe Morano, would like to have an automated river gage on the Raccoon River in the vicinity of SW 7th Street. Currently, there is not a good way to determine river heights in this area.

11. The downtown levee system and its operation require a fairly sophisticated level of automation. A new computerized system shows pump station operation and status. Some gates are automated and include water level sensors.

12. The Downtown east system starts near the Botanical Center. The upper portion is not included in system right of way, yet provides protection to the upper end of the system. The Botanical Center has planted trees and landscaped the levee area. Many of these plantings could adversely affect levee performance and flood fighting activities. This area should be redesigned and incorporated into the project to serve both purposes.

13. Some places were difficult to access or too steep to properly mow. The levee between SE 9th and SE 14th should be reconstructed.

14. There were at least two manholes in the center of the levees (Downtown west system). The manholes appeared to be at least 30 feet deep and intersected a storm pipe that penetrated the levee. It would enhance the system if these manholes where not in the levee and included sluice gates for positive closure.

15. Some of the sluice gates cannot be tested without dumping sanitary sewer into the river. These gates are normally closed. The City has been steadily separating storm sewers from sanitary sewers. Only during certain storm events in some areas do the two sewer systems combine.

16. The City provided the inspectors with pump station schematics that described the pump stations and the associated gatewell layout. The City also provided a list of gatewells.

17. Dean Cerny, Design Engineer talked to Scott Ralston, City of Des Moines Stormwater management on Wednesday via phone. Both Scott and Jim Morano would like to know what the schedule is for Central Place improvements. Scott said the City had money allocated to replace the existing pumps with new submersible pumps

Reach-3, Downtown East Inspection Summary
List of Gatewells and Levee Closures, see table below. A list of the Floodwalls and Riprap can be found in Table 21.

Table 20 Levee Features, Downtown Levee Systems

Description	Station	Elevations	DM #
Beginning of improved levee, north of I-235, left bank (east) of the Des Moines River. Levee continues upstream for about another 500 feet. This portion of levee includes landscaping – across from the botanical center	11+60	32.2	
East River Drive catch basins, are lower than top of levee and are not protected with a gatewell	9+30		
Gatewell "A", 48 inch RCP storm	16+12	Inv 15.0	555
Gatewell "B", 30 inch RCP storm, gatewell is located 6 to 8 ft outside of flood wall	31+27	Inv 5.4	565A
Pump station, storm water north of Amory Bldg.	31+27		565B
Gatewell, 42 inch storm, from pump station north of Armory	31+60		565C
12 inch cast iron pipe from Armory, shown on original drawings, status unknown	32+51		
12 inch cast iron pipe from Armory, shown on original drawings, status unknown	34+00		
Gatewell "B-1", 42 inch RCP storm, gatewell is located 10 ft outside of flood wall	34+88	Inv 9.7	567
Sandbag road levee closure, Grand Avenue	38+00		73
Gatewell "C", 42 inch RCP CSO Sanitary. Located at East Grand Avenue	38+09	Inv 6.7	661
Sandbag road levee closure, Locust Street	41+30		75
Abandoned Gatewell "D", 36 inch RCP, CSO, removed as part of Amphitheater project	41+88	Inv 8.0	N/A
Amphitheater, sandbag closures, 6 open areas			77A&B
Sandbag road levee closure, Walnut Street	45+00		79
Sandbag road levee closure, Court Avenue	50+50		81
Abandoned Gatewell "E", 24 inch RCP storm	52+72	Inv 15.0	575?
Sandbag railroad bridge closure	53+19		85
6 inch pipe through wall with flap gate			
Sandbag railroad bridge closure	55+60		87
Gatewell "F", 10" VIT Clay storm sewer	57+35	Inv 0.3	589
Gatewell, 84 inch storm	58+90		591
Pump Station, East 1st Street and Market, river outlet below top of floodwall. During a flood, gate 591 is closed and pumped through the station	59+80		
6 inch tideflex valve through flood wall	62+50 +/-		
Gatewell, 6 inch storm, under power lines	63+75 +/-		595
Gatewell "G", 5ft by 5ft box culvert sanitary, located	76+50	Inv 1.6	409

Description	Station	Elevations	DM #
flush with top of Scott Ave			
Gatewell, 78 inch RCP sanitary			415
Gatewell "I", 24 inch RCP storm	81+39	Inv 6.0	305
Railroad sandbag levee closure	84+00		41
Abandoned Gatewell "J", 12 inch RCP sanitary	86+66	Inv –0.5	429
Abandoned Gatewell "K", 36 inch RCP	96+71	Inv 11.6	N/A
Abandoned Gatewell "L", 12 inch VIT sanitary	97+02	Inv 4.36	N/A
Abandoned Gatewell "M", 24 inch VCP	102+70	Inv 0.83	N/A
Gatewell, 78" RCP storm (Previously gatewell "N")	110+00	Inv 0.44	325B
Pump station, SE 9th Street. Pressure pipe to pump station does not appear to have positive closure.	110+00		325A
Abandoned Gatewell "O", 18" RCP storm, east of SE 14th Street – levee height is 25.8 ft	118+11	Inv 2.32 ft	N/A
Gatewell, 48 inch storm, from pump station	124+85		339
Gatewell "P", 30 inch CMP, 10 gage, storm, east of pump station outlet	125+29	Inv 4.83	341B
Gatewell, 60 inch RCP storm, pump station outlet	154+20	Inv 0.2	345
Abandoned gatewell "Q", 30 inch RCP sanitary	169+75	Inv 4.35	356
Railroad sandbag levee closure, sheet pile cut off is 47 ft 5 inch wide with a top elevation of 19.7. Top of levee is 25.8.	170+65		45
Flap gate, 12 inch CMP, Flap gate is silted in, culvert inlet is not visible.	1+00E		
End of Stage I Levee Improvements	14+45E	Top of levee 22.5	
Gatewell, 36 inch storm, located on tie back near Dean's Lake. Tie back is lower than mainstem levee			355
Gatewell, 2 gates, 42 inch storm			351 A&B
Gatewell, 24 inch RCP storm			353
Gatewell, 90 inch RCP sanitary			461
Gatewell, 24 inch RCP storm			371
Gatewell, 90 inch RCP sanitary			467
Gatewell, 78 inch storm			375
Gatewell, 60 inch sanitary, plant outfall			471
Gatewell, storm, No 95-SL-5			377
Gatewell, 78 inch RCP storm			379
Gatewell, 84 inch RCP sanitary, primary plant outfall			479
Gatewell, 24 inch storm			381
Sandbag road closure, east of treatment plant			51
CORPS OF ENGINEERS LEVEE			
Gatewell, storm – City Operated			385
Gatewell, storm			395
Gatewell, storm			397

Description	Station	Elevations	DM #
Gatewell, storm			6
Gatewell, storm			7
Sandbag road closure, SE 45th Street			C
Gatewell, storm			8
Pump station and gatewell outlet			9
Road Closure Vandalia Road			B
Railroad closure			A
Gatewell, sanitary sewer, Pleasant Hill			493
Gatewell, storm			497

Table 21 List of Floodwalls and Riprap, Reach 3

Description	Station	Top elevation	River system
Precast flood wall	27+35 to 37+81.8A	32.2	Des Moines
Flood wall, City Hall	38+27 to 41+10	30.2	Des Moines
Floodwall, Amphitheatre			Des Moines
Floodwall	53+40.3A to 55+48.7A	29.5	Des Moines
Floodwall	55+94.5A to 57+80	29.5	Des Moines
Flood wall	60+30 to 62+75	29.5	Des Moines
R/S slope stone protection	63+40 to 110+00		Des Moines

Table 22 Downtown Reaches, Preliminary Cost Estimate, 200-Year Height

Downtown Reaches Preliminary Cost Estimate, 200 YR, Des Moines Flood Study

Code of Accnt	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency Amount	TOTAL COST With Contg
	DOWNTOWN EAST, Reach 3							
1	Lands and Damages							
	Downtown East							
	Non-Federal	1	LS	$3,700.00	$3,700.00	0%	$0.00	$3,700.00
	Federal	1	LS	$5,000.00	$5,000.00	0%	$0.00	$5,000.00
	SUBTOTAL LANDS AND DAMAGES							$8,700.00
11	Levees and Floodwalls							
	Tie to I-235	1	LS	$112,175.00	$112,175.00	25%	$28,043.75	$140,219.00
	Amphitheater Mods	1	LS	$44,670.00	$44,670.00	50%	$22,335.00	$67,005.00
	RR 1st South Court Ave	1	LS	$3,500.00	$3,500.00	50%	$1,750.00	$5,250.00
	RR 2nd South Court	1	LS	$7,760.00	$7,760.00	50%	$3,880.00	$11,640.00
	Grand Ave East	1	LS	$26,380.00	$26,380.00	25%	$6,595.00	$32,975.00
	Locust Street East	1	LS	$17,690.00	$17,690.00	25%	$4,422.50	$22,113.00
	Walnut Street South	1	LS	$35,000.00	$35,000.00	25%	$8,750.00	$43,750.00
	Court Ave North	1	LS	$21,490.00	$21,490.00	25%	$5,372.50	$26,863.00
	Court Ave South	1	LS	$21,490.00	$21,490.00	25%	$5,372.50	$26,863.00
	Downtown East RR Closure	1	LS	$5,880.00	$5,880.00	50%	$2,940.00	$8,820.00
	RR Closure DM #41	1	LS	$2,170.00	$2,170.00	50%	$1,085.00	$3,255.00
	DM Closure 51 Vandalia Rd	1	LS	$45,725.00	$45,725.00	25%	$11,431.25	$57,156.00
	SUBTOTAL LEVEE AND FLOODWALLS			$343,930.00			$101,977.50	$445,909.00
	TOTAL ESTIMATED CONSTRUCTION COST							**$445,909.00**
30	Planning, Engineering and Design @ **30%**							$133,772.70
31	Construction.Management @ **12%**							$53,509.08
	TOTAL COST **DOWNTOWN EAST**							**$641,890.78**

Downtown Reaches Preliminary Cost Estimate, 200 YR, Des Moines Flood Study

Code	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency	TOTAL COST
	DOWNTOWN WEST, Reach 4							
1	**Lands and Damages**							
	Downtown West							
	Non-Federal	1	LS	$3,700.00	$3,700.00	0%	$0.00	$3,700.00
	Federal	1	LS	$5,000.00	$5,000.00	0%	$0.00	$5,000.00
	SUBTOTAL LANDS AND DAMAGES							$8,700.00
11	Levees and Floodwalls							
	2nd RR South of Court	1	LS	$3,125.00	$3,125.00	50%	$1,562.50	$4,688.00
	1st RR South of Court	1	LS	$7,530.00	$7,530.00	50%	$3,765.00	$11,295.00
	Grand Avenue	1	LS	$46,760.00	$46,760.00	25%	$11,690.00	$58,450.00
	Walnut Street	1	LS	$22,215.00	$22,215.00	25%	$5,553.75	$27,769.00
	East Locust Street	1	LS	$20,880.00	$20,880.00	25%	$5,220.00	$26,100.00
	Court Avenue	1	LS	$38,925.00	$38,925.00	25%	$9,731.25	$48,656.00
	SUBTOTAL LEVEE AND FLOODWALLS			$139,435.00			$37,522.50	$176,958.00
	TOTAL ESTIMATED CONSTRUCTION COST							**$176,958.00**
30	Planning, Engineering and Design @ **30%**							$53,087.40
31	Construction Management @ **12%**							$21,234.96
	TOTAL COST **DOWNTOWN WEST**							**$259,980.36**

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Downtown Reaches Preliminary Cost Estimate, 200 YR, Des Moines Flood Study

Code	Item Description	Qty	UOM	Unit Cost	Total	Cont %	Contingency	TOTAL COST
	DOWNTOWN SOUTH, Reach 5							
1	Lands and Damages							
	Downtown South							
	Non-Federal	1	LS	$3,700.00	$3,700.00	0%	$0.00	$3,700.00
	Federal	1	LS	$5,000.00	$5,000.00	0%	$0.00	$5,000.00
	SUBTOTAL LANDS AND DAMAGES							$8,700.00
11	Levees and Floodwalls							
	DM #42	1	LS	$4,630.00	$4,630.00	50%	$2,315.00	$6,945.00
	DM #36	1	LS	$5,750.00	$5,750.00	50%	$2,875.00	$8,625.00
	SUBTOTAL LEVEE AND FLOODWALLS							$15,570.00
	TOTAL ESTIMATED CONSTRUCTION COST							**$15,570.00**
30	Planning, Engineering and Design @ **30%**							$4,671.00
31	Construction Management @ **12%**							$1,868.40
	TOTAL COST **DOWNTOWN SOUTH**							**$30,809.40**
	TOTAL PROJECT COST							**$932,681.54**

NOTE: Basis for estimate from MCACES file for Downtown Reach. Construction costs included overhead and profit. Price Level May 2004

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Table 23 Downtown West, Reach 4, List of Gatewells and Levee Closures

Description	Station	Elevations	DM #
Raccoon River			
Railroad levee closure 2 Single Leaf Swing Gates	-12+00	Sill: Top:36.3	15
30 inch CMP, 48 inch manhole with flap gate	-8+71	Inv 14.9	131
10 inch cast iron pipe with flap gate on end	-6+27	Inv 13.4	133
Gatewell, 78 inch sanitary sewer	-1+38		245
Gatewell "O", twin 78 inch storm	-1+13	Inv 15.87	135 A&B
30 inch water main crossings, near dam	17+85		
Gatewell, 18 inch storm	18+75		143
Gatewell, 72 inch sanitary and 42 inch to river closed	35+45		265 A&B
Gatewell "L", 48 inch CMP storm	35+85	Inv 14.1	151
Gatewell from new pump station/storm drain – Was Gatewell "M", 48 inch CMP storm	41+56	Inv. 13.5	153
Gatewell "J", 30 inch CMP storm, inverted to miss 78 inch sanitary	48+00	Inv 11.9	157
Railroad levee closure, 62 inch high swing gate	63+15	Sill 26.9 Levee 33.1 u/s Levee 32.4 d/s	19
Manhole in 24 inch CMP with flap gate	69+00	Inv 24.2 Outlet 13.9	165
Manhole center of levee, 96-inch storm gate Under SW 9th Street	75+00		275
Gatewell, Sanitary	79+80		Not Assigned
Sanitary vault, river side of levee, 78 inch sanitary sewer	80+30		
Gatewell, 72 inch storm from pump station, gravity outlet	80+30		175C
Valvewell, 3 ea 36 inch storm from pump station	81+80		175
Manhole, with 24 inch CMP and flapgate	84+00	Inv 21.4 Outlet 14.2	181
Gatewell, 72 inch storm, from pump station	91+00	Inv 8.76 at outlet	185C
Gatewell, 48 inch RCP Sanitary	95+54	Inv 1.5	285
Des Moines River			
Gatewell, 54 inch sanitary	8+20B		295
Sandbag levee closure	7+60B	2 ft low	27
Sandbag levee closure	6+10B	4.5 ft low	29

Description	Station	Elevations	DM #
Sandbag levee closure	3+40B		31
Gatewell "I", 60 inch RCP sanitary	124+11	Inv 8.6	690
Sandbag levee closure	123+00	3.3 ft low	94
Manhole, center of levee, at Market Street	118+30		
Sandbag levee closure over active railroad	114+50	3 ft low	88
Sandbag levee closure over inactive railroad	112+35		86
Panel levee closure over Riverside Drive	110+00	Sill 23.6 Top 29.6	84
Gatewell "H", 36 inch RCP sanitary, in Court Avenue – Is this active or abandoned?	109+65	Inv 9.3	??
Sandbag road closure, Court Avenue	109+40		82
Abandoned Gatewell "G", 18 inch sanitary	107+50	Inv 6.1	590?
Manhole, center of levee connected to deep storm sewer	104+50		
Gatewell "F", 36 inch sanitary - CSO	104+47	Inv 8.9	670
Sandbag road closure, Walnut Street	104+00		80
Gatewell 36 inch RCP storm, north of Walnut Street	103+30		584
Gatewell "E", 36 inch RCP storm south of Locust	100+71	Inv 8.3	582
Sandbag road closure, Locust Street	100+40		78
Gatewell "D", 96 inch RCP storm	99+26	Inv 0.6	578
Sanitary vault, landside of levee, 36 inch CSO connects to 60 inch sanitary	97+75		658
Sandbag road closure, Grand Avenue	97+25		76
Gatewell "C", 36 inch sanitary CSO, center of Grand Avenue	97+23	Inv 8.6	656
Gatewell "B", 36 inch storm	96+74	Inv 11.7	570
Gatewell "A", 60 inch sanitary with 60 inch outfall, gate kept closed	88+35	Inv to river 15.0, inv gate 1: 12.5	650 A&B

Table 24 List of Floodwalls and Riprap, Reach 4

Description	Station	Top elevation	River system
Floodwall, 12 inch cast in place	–12+60 to –3+85	36.3	Raccoon River, north bank
Riprap	-11+60 to 17+60		Raccoon River, outside bend of river
Flood wall, 7 inch pre-cast to 12 inch cast in place	9+50 to 13+75 13+75 to 16+75	35.16	Raccoon River, north bank
Riprap	39+30 to 45+30		Raccoon River, north bank
Riprap	63+00 to 70+00		Raccoon River, north bank
Riprap	83+50 to 92+50		Raccoon River, north bank
Floodwall, 7 inch pre-cast	96+75 to 88+35	31.2	Des Moines, west bank, south of Center Street Dam

Table 25 Downtown South, Reach 5, List of Gatewells and Levee Closures

Description	Station	Elevations	DM #
Raccoon River			
Railroad sandbag levee closure, upstream end of system near SW 7th Street	0+00 levee elev: 30.8	Top sheet pile: 28.0 Base of rail: 28.5 36 ft wide	36
Gatewell "A", 36 inch RCP sanitary sewer	0+25	Inv 9.9 Top 31.3	280
78 inch sanitary sewer constructed in 1966 runs along r/s toe of levee and under portions of levee	2+00 to 32+00		
36 inch sanitary sewer is located along l/s toe of levee	4+00 to 32+00		
Gravel drive is located on levee	5+00 to 7+60		
12 inch CMP with flap gate	4+00		
12 inch CMP with flap gate, may have been removed	10+50		
4 inch flap gate on drain pipe	11+85	19.3	
Road closure, Jackson Avenue	14+00		38
15 inch CMP storm, connects road inlet	13+70 to 14+25		
Gatewell, sanitary	15+00		190
Gatewell, 36" and 24", sanitary siphon	21+00		286
Gatewell "B", 36 inch sanitary	30+80	Inv 7.2	290
Des Moines River			
SW 1st Street and Scott Avenue – 78 inch sanitary, 36 inch sanitary, and 15 inch storm converge across intersection.			
Gatewell "C", 15 inch storm, outlet combines with curb inlet to 18 inch outlet	32+00	Inv 17.5	310
Gatewell, 36 and 78 inch sanitary	32+25		410 A&B
Railroad sandbag levee closure	34+04 levee elev: 28.5 u/s 27.5 d/s	Top sheet pile: 25.3 Base of rail: 25.8 44 ft wide	42
Pump Station gatewell, Vanburen and SE 1st Street, 60 inch storm	34+70		320
Abandoned Gatewell "D", 36 inch storm	43+64	Inv 2.5	328
Pump Station gatewell, Vanburen and SE 4th Street	47+50		330 A,B,&C

48 inch water main identified on as-built construction drawings	67+70		
Gatewell "E", 2 gates, 36 inch sanitary, includes bypass to grit chamber	67+80	Inv 2.2	420 A&B
Gatewell, Sta 73+60, 3 ea 6' by 6' box culverts, storm from ponding area	73+60	Inv 3.7	340 A,B,&C
Gatewell "F", 24 inch storm, east of SE 14th Street	0+30J	Inv 2.9	350
Gatewell, 72 inch sanitary sewer	14+50J		430
Manhole, CMP with flap gate			358
Manhole, CMP with flap gate			362
48 inch RCP connects small ponding area to large ponding area			
4ft by 5ft precast box culvert connects large ponding area with south east inlet			
Chain link fence surrounds ponding area			
Drainage ditch in ponding area connects southwest inlet with gatewell/box culverts at Station 73+60			

Table 26 List of Floodwalls and Riprap, Reach 5

Description	Station	Top elevation	River system
Precast floodwall	11+51.6 to 13+67.3	30.8 Bottom of foundation el 22.3	Raccoon River

Table 27 Downtown Levee Systems–Structural and Operational Deficiencies

Description of deficiency Downtown East, Reach 3	Recommended solution to problem	Project Recommendation
Simplify operating requirements by reducing closure requirements.		
Sta 11+60, north end of levee is not well defined and includes operational closures. Landscaping and unprotected storm drains affect this area.	Tie levee into I-235 embankment. This would reduce operation requirements during a flood and ease restrictions on landscaping north of the interstate.	**Yes**
Sta 38+00, DM 73, Sandbag closure, Grand Ave	Reduce width and height of closure by tying levee into existing bridge abutments	**Yes**
Sta 41+30, DM 75, Sandbag closure, Locust St	Reduce width and height of closure by tying levee into existing bridge abutments	**Yes**
DM 51, Sandbag closure over gravel road at Wastewater Treatment Plant	Eliminate closure by building up road over levee. See sheet DMR3-11	**Yes**
Sta 42+35 and Sta 43+50, DM 77 A&B, amphitheater pedestrian walkways	Simplify closure operation and increase reliability by cutting stop log slots into concrete posts	**Yes**
Sta 45+00, DM 79, Sandbag closure, Walnut St	Reduce width and height of closure by tying levee into existing bridge abutments	**Yes**
Sta 50+50, DM 81, Sandbag closure, Court Ave	Reduce width and height of closure by tying levee into existing bridge abutments	**Yes**
Sta 53+19, DM 85, Sandbag closure, inactive railroad south of Court Ave	Eliminate closure. The Riverwalk Project is upgrading this bridge and plans include raising the deck to eliminate the closure.	**Yes**
Sta 55+60, DM 87, Sandbag levee closure over 2nd railroad south of Court Ave	Reduce closure by extending floodwall closer to track	**Yes**
Sta 84+00, DM 41, Sandbag closure, inactive railroad near SE 4th St	Eliminate closure	**Yes**
Sta 170+65, DM 45, Earth levee closure at Des Moines Asphalt	Reduce closure by constructing levee and/or floodwall closer to track	**Yes**

Description of deficiency Downtown East, Reach 3	Recommended solution to problem	Project Recommendation
Gatewell and Utility Deficiencies.		
Sta 31+27, Gatewell "B" is located 6 to 8 ft outside of floodwall	Encase gap between gatewell and floodwall to provide uniform line of protection. The preferred configuration is to keep the sluice gates in line with the flood wall to provide a uniform line of protection	**Not recommended due to low priority.**
Sta 32+51 and 34+00, 12 inch cast iron pipes, shown on as-built drawings exiting from armory bldg.	Ensure pipes were removed or adequately sealed	
Sta 34+88, Gatewell "B-1" is located 10 ft outside of floodwall	Encase gap between gatewell and floodwall to provide uniform line of protection. The preferred configuration is to keep the sluice gates in line with the flood wall to provide a uniform line of protection	**Not recommended due to low priority.**
Sta 55+00A, 6 inch pipe through flood wall with flap gate protection, north of Vine St.	Relocate pipe or construct positive closure in addition to flap gate	
Sta 57+35, Gatewell "F" 10 in VIT storm sewer	Relocate pipe or replace with RCP	
Sta 60+20, storm water pump station outlet is through floodwall	Place stone protection below outlet to protect earth levee embankment	
Sta 62+50 +/-, 6 in tideflex valve on pipe that penetrates flood wall	Relocate pipe or construct positive closure in addition to flap gate	
Sta 66+00 to sta 97+00, box culvert located near levee toe on l/s	This is a large sewer line. If it broke, it could easily cause a sinkhole and collapse of the levee system.	City of Des Moines should inspect this line frequently and repair or upgrade when signs of deterioration are first noticed.
Sta 79+40, 78 inch sanitary sewer line	This is a large sewer line. If it broke, it could easily cause a sinkhole and collapse of the levee system.	City of Des Moines should inspect this line frequently and repair or upgrade when signs of

Description of deficiency Downtown East, Reach 3	Recommended solution to problem	Project Recommendation
		deterioration are first noticed.
Sta 110+00, 9th Street pump station, pressure pipe does not appear to have gate for positive closure	Relocate pipe over the line of protection or construct gatewell	
Sta 125+29, Gatewell "P" DM 341B, 30 inch CMP-10 gage with sluice gate	Replace CMP with RCP	City to replace with RCP when required
Sta 1+00E, silted in flap gate on 12 inch CMP	Remove CMP and flap gate	
Aging levee systems and structural components require periodic upgrade.		
Sta 29+20, River bank upstream of Center Street Dam, erosion near levee. Concrete apron has large crack.	Repair eroded bank and fill/grout crack in concrete apron.	
Sta 76+50 to Sta 100+00, existing riprap is beginning to deteriorate	Place a new blanket of riprap along the lower bank. Approximately 6,000 tons.	
Improve levee embankment and increase levee height or strength in identified areas.		
Sta 110+00 to Sta 116+00, levee between SE 9th and Se 14th has a substandard cross section and has experienced poor performance.	Rebuild this section of levee to include an inspection trench. Requires about 4,000 CY of new embankment.	
The Downtown east levee system, reaches 11 and 12 are very long, approximately 10 miles.	Search for possible tie-back locations so that a break in one area does not flood the entire interior area.	No obvious tie-back locations were identified.
Optional system improvement.		
Sta 63+25 to Sta 76+00, l/s levee slope is steep	Purchase additional right of way and add embankment to flatten slope and facilitate mowing	

K. Reach-4, Downtown West Inspection Summary

See the following Tables.

Table 28 Reach-4, Downtown West,

Negative Stations are beyond the Des Moines River and up the Raccoon River.

Description of deficiency Downtown West, Reach 4	Recommended solution to problem	Project Recommendation
Simplify operating requirements by reducing closure requirements.		
Sta 63+15 Raccoon River, DM 19, Inactive railroad with swing gate	Construct permanent levee closure	
Sta 93+00 Raccoon River, DM 23, Sandbag levee closure SW 5th Street, Jackson Ave	Construct permanent levee closure	Yes
Sta 97+25, DM 76, Sandbag closure, Grand Ave	Reduce width and height of closure by tying levee into existing bridge abutments	Yes
Sta 100+40, DM 78, Sandbag closure, Locust St	Reduce width and height of closure by tying levee into existing bridge abutments	Yes
Sta 104+00, DM 80, Sandbag closure, Walnut St	Reduce width and height of closure by tying levee into existing bridge abutments	Yes
Sta 109+40, DM 82, Sandbag closure, Court Avenue	Reduce width and height of closure by tying levee into existing bridge abutments	Yes
Sta 110+00 Des Moines River, DM 84, Panel levee closure, River Drive	Eliminate closure	Principal Riverwalk to develop design and construct
Sta 112+35 Des Moines River, DM 86, Sandbag closure, Inactive Railroad	Eliminate closure	Principal Riverwalk to develop design and construct
Sta 114+50 Des Moines River, DM 88, Sandbag levee closure over railroad, 2nd railroad south of Court Ave	Reduce width of closure	Yes
Sta 123+00 Des Moines River, DM 94, Sandbag closure SW First St	Eliminate closure by building up roadway	Not recommended due to relatively high cost.

Description of deficiency Downtown West, Reach 4	Recommended solution to problem	Project Recommendation
Simplify operating requirements by reducing closure requirements.		
Sta 3+40B, DM 31, Sandbag closure at Sec Taylor parking lot	Eliminate closure by building up entrance	
Sta 7+60B, DM 27, Sandbag closure at Sec Taylor parking lot	Eliminate closure by building up entrance	
Sta 6+10B, DM 29, Sandbag closure at Sec Taylor parking	Reduce closure height and width if possible	
Gatewell and Utility Deficiencies.		
Sta –12+00 to Sta 79+80, 78 inch sanitary sewer line is located along levee alignment along the Raccoon River	This is a very large sewer line. If it broke, it could easily cause a sinkhole and collapse of the levee system.	City should inspect this line frequently and repair/ upgrade when signs of deterioration are first noticed.
Sta –8+71 Raccoon River, existing 30 in CMP with flap gate located in manhole	Replace CMP with RCP and install gatewell in addition to flap gate	
Sta –6+30 Raccoon River, flap gate on existing 10 in CI pipe	Verify whether pipe is still in use. Relocate pipe or install sluice gate	
Sta 17+00 Raccoon River, existing 30 inch water mains crossing levee	Determine age and condition of water mains. Determine if replacement or relocation is required	
Sta 35+85 Raccoon River, existing 48 in CMP with sluice gate	Monitor condition of CMP and replace CMP with RCP	
Sta 41+56 Raccoon River, existing 48 in CMP with sluice gate	Monitor condition of CMP and replace CMP with RCP	
Sta 48+00 Raccoon River, existing 30 in CMP with sluice gate	Monitor condition of CMP and replace CMP with RCP	
Sta 69+00 Raccoon River, existing 24 in CMP with flap gate located in manhole	Replace CMP with RCP and install gatewell in addition to flap gate	
Sta 75+00 Raccoon River, several existing utilities cross levee under SW 9th Street	Investigate existing utilities to ensure good condition and positive closure at the line of protection.	

Sta 84+00 Raccoon River, existing 24 in CMP with flap gate located in manhole	Replace CMP with RCP and install gatewell in addition to flap gate	
Sta 96+74 Des Moines River, Gatewell "B" is located inside existing flood wall leaving a gap between the wall and the gate structure	Tie gatewell into the line of protection. When floodwall is reconfigured to improve the closure, the gate can be tied to wall.	Yes
Sta 97+00 to Sta 100+40, 60 inch brick sanitary sewer line is located along l/s levee near Grand Ave to the south	If the line broke, it could easily cause a sinkhole and collapse of the levee system.	City should inspect this line frequently and repair/upgrade when signs of deterioration are first noticed.
Sta 104+50 Des Moines River, existing manhole in center of levee	Relocate manhole, construct new sluice gate	
Sta 118+30 Des Moines River, existing manhole in center of levee	Relocate manhole, construct new sluice gate	
Aging levee systems and structural components require periodic upgrade.		
Sta –11+60 to 17+60 Raccoon River existing band of riprap.	Place 5700 tons of riprap along lower riverbank to replenish existing riprap placed in 1970.	
Sta 39+30 to 48+00 Raccoon River, existing riprap area and eroded bank near levee	Place 3,000 tons riprap and 1,000 tons of bedding	
Sta 63+00 to 70+00 Raccoon River, existing band of riprap.	Place 2000 tons of riprap along lower riverbank to replenish existing riprap placed in 1970.	
Sta 83+50 to 88+50 Raccoon River, existing band of riprap.	Place 1000 tons of riprap along lower riverbank to replenish existing riprap placed in 1970.	
Sta 88+35, upstream end of levee, Des Moines River	Add 40 CY new embankment so that levee tie-off is as high as top of existing floodwall	
Sta 91+00 to 102+00, sediment/log jam inside bend, Raccoon River	Remove sediment and log jam from river, via SW 3rd Street	
Sta 122+20 – Des Moines River, concrete abutments in r/s levee slope	Remove abutments from old bridge to facilitate maintenance	

L. Reach-5, Downtown South Inspection Summary

See the following Tables.

Table 29 Downtown South, Reach 5

Description of deficiency Downtown South, Reach 5	Recommended solution to problem	Project Recommendation
Simplify operating requirements by reducing closure requirements.		
Sta 0+00 Raccoon River, DM 36, Sandbag closure, Inactive Railroad near SW 7th St	Eliminate closure	Yes
Sta 14+00 Raccoon River, DM 38, Earth closure, SW 5th St	Eliminate closure	City trail project is making this a permanent closure.
Sta 34+04 Des Moines River, DM 42, Sandbag closure, Inactive Railroad near SW 1st St	Eliminate closure	Yes
Gatewell and Utility Deficiencies.		
Sta 2+00 to 32+00, 78 inch sanitary sewer line is located along r/s toe of levee and under portions of the levee	This is a very large sewer line. If it broke, it could easily cause a sinkhole and collapse of the levee system.	City of Des Moines should inspect this line frequently and repair or upgrade when signs of deterioration are first noticed.
Sta 4+00 to 32+00, 36 inch sanitary sewer line is located along r/s toe of levee and under portions of the levee	If this sewer line broke, it could easily cause a sinkhole and collapse of the levee system.	City of Des Moines should inspect this line frequently and repair or upgrade when signs of deterioration are first noticed.
Sta 4+00, flap gate on 12 inch CMP	Relocate pipe or replace with RCP and add positive closure gate.	
Sta 10+50 and 11+85, as-built drawings show through pipes without adequate closure	Determine if pipes penetrate the levee system. Relocate or equip with positive closure devices	
Sta 14+00, 15 in CMP pipe penetrates levee without gate	Relocate or replace pipe with RCP and positive closure	
Sta 67+70, as-builds show 48	Investigate condition, size,	

Description of deficiency Downtown South, Reach 5	Recommended solution to problem	Project Recommendation
inch water main under levee	and pressure of water main. Relocate or rebuild if warranted.	
Aging levee systems and structural components require periodic upgrade.		
None observed during study investigation.	Verify whether aging components have caused problems or have potential to cause future problems.	Continue to work with and coordinate with City personnel
Improve levee embankment and increase levee height or strength in identified areas.		
Sta 0+00, Levee cross section around gatewell "A", DM 280, is not sufficient.	Add additional embankment around gatewell and upstream end of levee	
Sta 5+00 to 7+60, gravel drive is located on top of levee	Raise height of gravel drive to provide additional freeboard in this area.	
Sta 31+50, Utility lines, storm inlets, 2 bridges, SE 1st St, levee and gatewells converge at this location.	Accurately locate all utilities, survey surface elevation, and determine location of line of protection.	
Optional system improvements.		
Shape ponding area to improve drainage.	Not required for flood protection	
Construct a permanent pump station at the ponding area	This was a City request. During a flood and storm events, portable pumping is required. Constructing a permanent pump station would alleviate City resources during flood operations.	This pump station does not have sufficient justification for a federal interest.
Flap gates in 2 CMP pipes at Ponding area south of E. Hartford Ave. DM 358 and 362.	Construct positive closure on existing pipes or method to stop reverse flow when ponding area is full and flap gates malfunction.	

Table 30 Downtown Levees Road Closure Considerations

Sta	Location	DM Number	Existing Width	New Width	% Improvement	Recommended Improvements	Remarks
		#	feet	feet			
	Downtown East						
11+60	Close upstream end of levee	N/A	60	0	100	Tie levee into I-235 embankment	Allows Botanical Center to plant/landscape existing levee without compromising the City levee system
6	Amphitheater sidewalk	77A	7.7	7.7	50	Cut stop log slots to assist with closure and seal	Simplifies closure and allows a closure with more reliability
7	Amphitheater sidewalk	77B	7.4	7.4	50	Cut stop log slots to assist with closure and seal	Simplifies closure and allows a closure with more reliability
8	Railroad, 2nd south of Court Ave, east	87	45	20	55	Extend floodwall closer to railroad tracks	Minimizes size of opening
11	Railroad, 1st south of Court Ave, east	85	40	0	100	Make permanent closure	
12	Grand Avenue, east	73	85	85	30	Tie levee into bridge abutments, reduces closure height by about 1 foot	Reduces closure to bare minimum, keeps road open longer, increases installation time
14	Locust Street, east	75	85	70	41	Tie levee into bridge abutments, reduces closure height by about 1 foot	Reduces closure to bare minimum, keeps road open longer, increases installation time, and increases reliability

Sta	Location	DM Number	Existing Width	New Width	% Improvement	Recommended Improvements	Remarks
		#	feet	feet			
16	Walnut Street, east	79	150	85	43	Tie levee into bridge abutments, cut slots in amphitheater opening	Reduces closure to bare minimum, keeps road open longer, increases installation time, and increases reliability
18	Court Avenue, east	81	165	100	40	Tie levee into bridge abutments	Reduces closure to bare minimum, keeps road open longer, increases installation time
25	Railroad at Des Moines Asphalt	45	150	60	60	Minimize closure width	
26	RR Bridge Bike Trail at SE4th & Shaw	41	50	0	100	Make permanent closure	
28	Carlisle Road south of Vandalia Road	51	100	0	100	Raise road to eliminate closure	
	Downtown West						
9	Railroad, 2nd south of Court Ave, west	88	80	20	75	Minimize closure width	
10	Railroad, 1st south of Court Ave, west	86	140	0	100	Riverwalk work is planning on eliminating this closure	
13	Grand Avenue, west	76	120	80	35	Tie levee into bridge abutments	
15	Locust Street, west	78	100	70	30	Tie levee into bridge abutments	
17	Walnut Street, west	80	135	85	40	Tie levee into bridge abutments	
19	Court Avenue, west	82	150	100	35	Tie levee into bridge abutments	

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Sta	Location	DM Number	Existing Width	New Width	% Improvement	Recommended Improvements	Remarks
		#	feet	feet			
20	Riverside Drive Panel Closure	84	50	0	100	Riverwalk work is planning on eliminating this closure	
21	SW 1st south of Elm	94	90	0	100	Eliminate closure, construct road over line of protection	
22	Sec Taylor Parking Lot at SW 2nd	31	75	0	100	Eliminate closure, construct drive over line of protection	
23	Sec Taylor Parking Lot at SW 2nd	29	100	100	0	Reduce closure height and width if possible	
24	Sec Taylor Parking Lot at SW 2nd	27	70	0	100	Eliminate closure, construct drive over line of protection	
29	SW 5th (Jackson) Street, north	23	110	0	100	Make permanent closure	
32	Railroad upstr SW 9th, Swing Gate	19	20	0	100	Make permanent closure	
33	Railroad upstr Fleur Drive, Swing Gate	15A	20	20	0	No work required	
34	Railroad upstr Fleur Drive, Swing Gate	15B	20	20	0	No work required	
	Downtown South						
27	Railroad at SE1st & VanBuren	42	70	0	100	Make permanent closure	
30	SW 5th (Jackson) Street, south	38	70	0	100	Make permanent closure	
31	Railroad east of SW 7th Street	36	60	0	100	Make permanent closure	
	Total @ Des Moines River - Downtown		**2,425**	**930**	**62**		

5. REACH 6 RACCOON RIVER 205 LEVEE SYSTEM

The existing Raccoon River levee system was designed and constructed by the U.S. Army Corps of Engineers after the 1993 floods under the authority of the Continuing Authorities Program Section 205. The City of Des Moines operates and maintains the levee system. The Section 205 levee design flood profiles were based upon updates to the Raccoon River flow-frequency characteristics as revised by the 1993 flood event. As such, the levee system provides a high and reliable level of protection. This feasibility study performed a cursory evaluation of further upgrades to the levee, but further improvements were determined to be not warranted.

6. REACH 7 DES MOINES WATER WORKS LEVEE SYSTEM

The Des Moines Water Works is a private corporation that provides the freshwater supply to the City of Des Moines. Within the ring levee is the water treatment plant that serves the City and surrounding communities. The treatment plant flooded during the Great Flood of 1993. Following the flood, the Des Moines Water Works improved the levee by increasing the height of the levee and installing additional closure structures.

Currently, the top of the improved levee is higher than any of the existing Des Moines levee systems. During the course of this study, the design team did not evaluate the structural integrity of the system to withstand significant flood events. The Des Moines Water Works did relate that areas within the ring levee get soft and saturated during a major flood. This can be caused by under-seepage that results from pervious layers of earth material. Another cause could be utility penetrations that allow piping or seepage along the utility. To evaluate structural integrity of the levee and its foundation, a series of soil borings, utility search, and other construction records are required. A follow-on assessment and analysis of the system could then be undertaken. It is recommended that the City pursue this type of engineering analysis by requesting a U.S. Army Corps of Engineers PL 84-99 eligibility inspection. If the levee meets minimum requirements, it can be allowed into the Pl 84-99 program and receive annual inspections, flood fighting assistance, and repair due to flood damages. The inspection report would include an analysis of the system and identify any potential deficiencies.

7. REACH 8 WEST DES MOINES RACCOON RIVER LEVEE SYSTEM

The existing Raccoon River levee system was designed and constructed by the U.S. Army Corps of Engineers after the 1993 floods as a specifically authorized flood damage reduction project with the cities of Des Moines and West Des Moines. The cities operate and maintain the levee system within each of their respective jurisdictions. The levee design flood profiles were based upon updates to the Raccoon River flow-frequency characteristics as revised by the 1993 flood event. As such, the levee system provides a high and reliable level of protection. This study performed a cursory evaluation of further upgrades to the levee, but further improvements were determined to be not warranted.

8. REACH 9 WALNUT CREEK AT GRAND AVENUE

A. Background

Walnut Creek flows through an 84-square mile watershed located along the west side of the City, in the western suburbs and Dallas County. The creek has experienced flash flooding on numerous occasions, including 1973, 1986, 1990, 1993, 1997 and 1998. The completed Corps of Engineers' West Des Moines – Des Moines Local Flood Protection Project provides comprehensive flood protection to the developed western bank floodplain area. The study area, currently under consideration, is the unprotected developed floodplain area located on the eastern bank of the creek in the vicinity of Grand Avenue. The 100-year floodplain in this area contains several businesses and residences.

B. Level of Protection

The level of protection for the east bank was set at 50.6 feet, City Datum. This provides protection for the 100-year event plus 4 feet of freeboard and equals that provided, at the Grand Avenue closure structure, by the completed West Des Moines – Des Moines Local Flood Protection Project.

C. Conceptual Design Analysis

The proposed alignment begins at the southern downstream end of the project by tying the levee into high ground behind residences on the west side of 58th Street north of Terrace Drive and continues northward until terminating at high ground behind residences on the north side of Walnut Hill Avenue. This proposal includes approximately 1,620 feet of levee, 780 feet of concrete floodwall, 2,150 feet of relocated sanitary sewer, 140 feet of relocated storm sewer, one overhead lift gate closure structure, one swing gate closure structure and three gatewells.

Real estate concerns may necessitate increasing the overall length of floodwall southward from station 11 + 78. This would result in a corresponding decrease in the length of the levee. If necessary, the increased use of floodwall would result in an increase in the project cost. If a project were pursued, these details would be addressed during the plans and specifications phase of this project.

The proposed alignment requires the partial closure of 62nd Street between Grand Avenue and Walnut Hill Avenue. This closure would include approximately 200 feet of roadway at the north end of the block. Access from Grand Avenue to existing businesses on both sides of 62nd Street would be maintained via 62nd Street, while access for residences on Walnut Hill Avenue would be maintained via 61st Avenue.

The levee would be constructed from impervious material with side slopes of 3-feet horizontal to 1-foot vertical and a 10-foot top width. The levee would be seeded for stabilization.

Due to the flash flooding tendencies of Walnut Creek, all of the closure structures incorporated into this proposal must have the capability of being closed rapidly with minimal manpower or equipment required.

The Grand Avenue closure structure is an overhead lift gate structure similar to the one successfully incorporated across Grand Avenue in the West Des Moines – Des Moines Local Flood Protection Project. Compared to a swing gate-type structure, an overhead lift gate structure minimizes the impact on adjacent Grand Avenue frontage property owners.

Access to the McDonald's Restaurant would be maintained from both Grand Avenue and 62nd Street. A 30-foot wide swing gate closure structure would be incorporated for the 62nd Street entrance.

Sections of both sanitary and storm sewers must be relocated from the footprint of the levee/floodwall. The new alignment would minimize the number of gatewells required and thus reduce the response time for a flood event.

The revisions to the sanitary sewer system include relocating 27-inch and 54-inch lines north of Grand Avenue and a 30-inch line south of Grand Avenue to the landside of the levee/floodwall. This alignment removes the sanitary sewer from the footprint of the levee/floodwall and requires only one new sanitary sewer gatewell.

The existing storm sewer system in the study area has two separate outfalls into Walnut Creek. The first outfall is a 36-inch line running along the south side of Grand Avenue while the second outfall is an 18-inch line midway between Grand Avenue and Walnut Hill Avenue. Each of these outfalls would require a separate gatewell. A pump station for interior drainage was not evaluated during this phase of the study.

The overall project construction cost estimate is summarized in Table 31.

See Appendix B, *Economic Analysis* for an evaluation of this design. The benefit to cost ratio is less than 1 and, therefore, does not indicate a federal interest in a cost shared project.

Table 31 Construction Cost Estimate Summary- Walnut Creek

Feature	Item		Unit Cost
001/ 005	Field Office w/Telephone		24,200
0010	Traffic Control		16,200
0015	Clearing and Grubbing		7,800
0020	Relocate 54" Sanitary Sewer		88,700
0025	Relocate 30" Sanitary Sewer w/1 gatewell		141,700
0030	Relocate 27" Sanitary Sewer		46,700
0035	Gatewell - 18" Storm Sewer		8,900
0040	Gatewell - 36" Storm Sewer		15,600
0045	Grand Avenue Closure Structure		456,700
	McDonald's Closure Structure		106,400
0050	Concrete Floodwall		302,200
0055	Levee		255,000
	Subtotal		1,470,100
	Contingency @	25%	367,500
	Total		**$1,837,600**

* All cost figures are rounded to the nearest $100

9. REACH 10 FOURMILE CREEK ANALYSIS

The Fourmile Creek floodplain contains numerous houses, mobile homes and businesses on the City's eastside. The area has experienced frequent flash flooding with very little emergency response time. The City has installed a flood-warning system to provide some advance warning time to evacuate people from the flood areas. However, there is not adequate response time to provide flood-fighting protection to most properties that have been damaged repeatedly over the years.

The U.S. Army Corps of Engineers completed a flood damage reduction study on Fourmile Creek in May 1975. This report considered alternatives for providing flood protection along the creek, including upstream reservoirs and several levee alignments. The data, findings and conclusions of the May 1975 study were reevaluated by the study team based upon Fourmile Creek flood profiles from Phase I of this study; as well as current topography mapping and housing/business development. The upstream reservoir sites identified in the 1975 study report are no longer available due to industrial development adjacent to Fourmile Creek in the Ankeny area. Additional reservoir sites are not available due to the relative flat topography of the Fourmile Creek watershed in northern Polk County and southern Story County.

Six levee alternative alignments from the 1975 study were reevaluated as part of this Reach 10 study effort. These six levee alignments are shown on Plates F1 – F7. Project and construction cost estimates from the 1975 study alternatives were indexed to current price levels. The indexed cost estimates for the six levee alternatives are listed on Table 32. These updated costs were then used in the new economic analysis that compared estimated flood damage reduction benefits to the associated project costs. The updated results corresponded with earlier 1975 findings that average annual costs greatly exceeded average annual benefits. Thus, the current study also concludes that there is no federal interest in a structural levee solution to the flooding problems along Fourmile Creek.

Table 32 Fourmile Creek Construction Cost Estimate Summary

Alternatives	Project Cost Est.	Annualized First Costs	Annual O & M Costs	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Benefits
Reach LB-2	3,790,000	240,785	3,100	243,785	13,451	0.06	-230,334
Reach RB-3	571,000	36,277	1,000	37,277	1,051	0.03	-36,226
Reach LB-4	2,690,000	170,900	3,000	173,900	11,716	0.07	-162,184
Reach RB-4 and 5	1,420,000	90,215	2,000	92,215	0	0.00	-92,215
Reach RB-6	165,000	10,483	1,000	11,483	1,109	0.10	-10,374
MH Park Buyout	2,150,000	146,764	0	146,764	47,416	0.32	-99,348
No Action	0	0	0	0	0	0	0

10.REACH 11 LEETOWN CREEKWAY

The Leetown Creekway (formerly 7th Ward Ditch) study area, Reach 11, included the area south of the Iowa State Fairgrounds on Des Moines' southeast side. The Reach 11 study area is a relatively small area that experiences infrequent stream flooding, but frequent stormwater drainage flooding. High Fourmile Creek flood levels further can impact on Leetown Creekway's ability to convey stormwater out of the low-lying portions of the watershed.

A concept alternative for providing flood damage reduction in the Leetown Creekway area was initiated that relocated the existing Red Rock Remedial Works tie-off levee along Leetown Creekway. The relocated levee alignment along Fourmile Creek to Scott Avenue would place the Reach 11 area on the protected side of the levee. The plan would have prevented Fourmile Creek from backing up into the Leetown Creekway floodplain. Leetown Creekway interior floodwaters would then be temporarily stored in the existing sand and gravel quarry located near the confluence of Leetown and Fourmile Creeks. The plan would have required the City of Des Moines to acquire flood easements from the quarry operator and landowner to allow the City to store stormwater in the quarry.

When the study finding was made that the existing Red Rock Remedial Works levee system provided a high and reliable level of protection, further analysis of Leetown Creekway flood damage reduction alternatives were terminated due to the relative low-level of existing flood damages.

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POLK COUNTY, IOWA

APPENDIX D

COST ENGINEERING

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The focus of this Cost Engineering Appendix is on Birdland Park Levee System, Central Place Levee System and the Downtown Levee Systems. As documented in Appendix C, Engineering, each of these reaches has features that need to be enhanced in order to improve performance of flood control system during occurrences of high water. Generally, there is concern about the materials used and/or placement practices during previously constructed portions of levee. There are also portions of the levee where there is erosion and undermining of thc levee slopes. Tree roots and debris also pose problems. The existing levee slopes are difficult to maintain because of the steep slopes. City officials experience difficulties in placement of closures that are required during flood fighting due to the number of closures that need to be made in a relatively short amount of time. Improvements to the Birdland Park Levee System include improvement/reconstruction of the levee (including construction of an inspection trench and seepage berm); replacement of existing gatewells; construction of a closure structure at Saylor Road; and mitigation. Improvements to the Central Place Levee System include construction of a clay face on the existing levee embankment; stone protection; construction of two new gatewells; construction of six new pump station discharge pipes and outlets; a levee tie-off at University Avenue; and mitigation. Improvements to the Downtown Levee System include reduction in the width of railroad closures; modifications to tie-ins (in some cases eliminating the need for some of the existing closures); placement of pallet barrier system; and several others.

This appendix includes preliminary estimates for Birdland, Central Place and the Downtown Reaches for the 100-year, 250-year, and 500-year levels of protection. The preliminary estimates are summarized in tables 1 through 7. These costs include relocations, construction, planning, engineering and design, and construction management. . The level of detail for the preliminary estimates is consistent with the level of design. Detailed estimates were developed for the recommended plan (Birdland, Alignment 2, 500 YR; Central Place 500 YR; and the Downtown Reach, 500 YR) and the Recreational Trail for Birdland using the Micro Computer Aided Cost Estimating System (MCACES), Version 1.2. The summary documents to these detailed estimates are contained it tables 8 through 11. These detailed estimates were prepared using preliminary project plans; information gathered from site visits; discussions with design team members and the local sponsor; and review of similar construction projects. Costs, including appropriate contingencies, are presented in accordance with: ER 1110-1-1300, Cost Engineering Policy and General Requirements; ER 1110-2-1302, Civil Works Cost Engineering; and EC 1110-2-538, Civil Works Project Cost Estimating – Code of Accounts.

PRICE LEVEL

The estimates are prepared to a May 2004 price level. These costs are considered to be fair and reasonable to a well-equipped and capable contractor and include overhead and profit. Calculation of the Fully Funded Estimate (FFE) was done in accordance with guidance from EM 1110-2-1304, Civil Works Construction Cost Index System (CWCCIS), updated September 2003. It was assumed that each reach would be a separate contract. The midpoint of construction, September 2008, was used to determine the FFE.

CONTINGENCY AND ASSUMPTIONS

After review of project documents and discussion with engineering and construction personnel involved in the project, cost contingencies were developed which reflect the uncertainty associated with each cost item. The contingencies factors were assigned based on qualified cost engineering judgment of the available design data, type of work involved, and uncertainties associated with the work and schedule. Generally, the contingency factors assigned are primarily due to the conceptual design of a project feature, unknown quantities, and unknown site conditions. Many of the project features can be constructed using conventional methods and are similar to previous Rock Island District projects.

Borrow will come from the Harriet Street landfill. Unsuitable levee materials and cleared and grubbed materials will be hauled off-site. Typically, the materials that are stripped from the area in preparation for the construction of the levee will be stockpiled and used for portions of the levee construction when feasible. The construction is not anticipated to be complex. New levee construction is likely less difficult than levee construction that involves the placement of a clay face. This is primarily due to the care that it will take to bench in the clay face along the existing levee section. It is assumed that the contractor will work on the levee in portions so that the construction does not jeopardize the line of protection the levee system provides should a high water event occur during the construction period. It is assumed that the contractor will be allowed a reasonable length of construction time to perform the work; therefore, overtime rates were not applied to the estimates. It is assumed that the construction method and practices would be efficient (i.e. minimize double handling of material when not necessary etc). Material prices are consistent with those used to develop unit costs in MCACES and/or from updated data from fairly recently constructed projects. The labor rates used are consistent with Davis Bacon Wage Rates for Polk County, Iowa. It is anticipated that the contractor will perform the work using conventional construction equipment including; but not limited to: dozers, backhoes, excavators, cranes, graders, and asphalt pavers.

Quantities and costs associated with the work features that Stanley Consultants Inc., Muscatine IA, prepared in their design analysis were used (and updated using the Engineering News Record (ENR) cost index tables to the extent possible during the preparation and development of the MCACES estimates for Birdland. Those features and updated costs that were based on Stanley's Report included: relocation of the waterline at Guthrie; clearing and grubbing; signage; chain link fence; Saylor Road Closure; Drainage Structure; Sta 201+00; and demolition and reconstruction of Gatewells A and B.

The Real Estate Costs for these project estimates are based on requirements for lands, easements, rights-of-way and land acquisition. (See Appendix F, Real Estate.) The Planning, Engineering and Design features for these project estimates are based on a percentage (15 percent for all estimates, except for the Downtown Closures which was at 30 percent) of the estimated construction costs with contingency. This effort includes development of the plans and specification, engineering during construction, and preparation of as-built drawings. The Construction Management features for these projects are based on a percentage (9 percent for all estimates, except for the Downtown Closures which was at 12 percent) of the estimated construction costs with contingency. This effort includes contract

administration, shop drawing review, inspection and quality assurance. These percentages were based on input from the RI Engineering Division and Construction Division based on costs associated with similar Rock Island District projects.

CURRENT WORKING ESTIMATES AND FULLY FUNDED ESTIMATES

Tables 12 thru 15 summarize the results of the MCACES estimates for Birdland, Alignment 2, 500 YR; Central Place 500 YR; the Downtown Reach 500 YR; and the Recreational Trail for Birdland. These estimates show the total project costs for the current working estimate and the FFE.

Table 1 Birdland Park Preliminary Cost Estimate 100-Year Height

Birdland Park 100-Year, Alignment 2, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
1	LANDS AND DAMAGES							
	Non-Federal	1	LS	$45,000.00	$45,000.00	0%	$0.00	$45,000.00
	Federal	1	LS	$610,000.00	$610,000.00	0%	$0.00	$610,000.00
	SUBTOTAL LANDS AND DAMAGES							$655,000.00
2	RELOCATIONS							
	Remove Waterline Guthrie Ave S	1,000	LF	$26.00	$26,000.00	15%	$3,900.00	$29,900.00
	Restore sidewalk & driveways Guthrie	3,500	SF	$6.50	$22,750.00	10%	$2,275.00	$25,025.00
	Replace Waterline Guthrie Ave N	1,000	LF	$52.00	$52,000.00	20%	$10,400.00	$62,400.00
	SUBTOTAL RELOCATIONS				$100,750.00			$117,325.00
11	LEVEES AND FLOODWALLS							
	Silt Fence	1,600	LF	$2.65	$4,240.00	15%	$636.00	$4,876.00
	Clearing and Grubbing	8.65	AC	$5,550.00	$48,007.50	15%	$7,201.13	$55,208.63
	Strip, Stockpile/Replace Topsoil	11,000	CY	$8.75	$96,250.00	15%	$14,437.50	$110,687.50
	Seeding	14	AC	$2,870.00	$40,180.00	15%	$6,027.00	$46,207.00
	Borrow, Haul Material	57,180	CY	$7.45	$425,991.00	15%	$63,898.65	$489,889.65
	Place, Shape Embankment	75,245	CY	$4.60	$346,127.00	15%	$51,919.05	$398,046.05
	Excavation/Disposal	25,300	CY	$3.65	$92,345.00	15%	$13,851.75	$106,196.75
	Bedding	1,931	TON	$29.00	$55,999.00	10%	$5,599.90	$61,598.90
	Riprap	5,363	TON	$47.75	$256,083.25	15%	$38,412.49	$294,495.74
	6th Ave Ramp Asphalt Pvmnt	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45
	6th Ave Ramp Prime Coat	267	GA	$4.90	$1,308.30	15%	$196.25	$1,504.55
	6th Ave Ramp Aggregate Base Course	677	TON	$28.65	$19,396.05	15%	$2,909.41	$22,305.46
	Signage and Striping	1	LS	$1,958.00	$1,958.00	15%	$293.70	$2,251.70
	Remove & Replace 8' Chain Link Fence	100	LF	$24.85	$2,485.00	15%	$372.75	$2,857.75
	Saylor Road Closure Structure	1	LS	$114,711.00	$114,711.00	15%	$17,206.65	$131,917.65
	Bike Path Asphalt Pavement	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45
	Bike Path Prime Coat	356	GA	$4.90	$1,744.40	15%	$261.66	$2,006.06
	Bike Path Aggregate Base Course	533	TON	$31.80	$16,949.40	15%	$2,542.41	$19,491.81
	Drainage Structure- Sta 201+00	1	LS	$32,878.00	$32,878.00	10%	$3,287.80	$36,165.80
	Drainage Structure Dewatering	1	LS	$39,156.00	$39,156.00	20%	$7,831.20	$46,987.20
	Demolish Gatewells A&B	1	LS	$13,052.00	$13,052.00	15%	$1,957.80	$15,009.80
	Reconstruct Gatewells A&B	1	LS	$35,240.00	$35,240.00	15%	$5,286.00	$40,526.00

Birdland Park 100-Year, Alignment 2, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
	Seepage Berm	20,000	CY	$5.35	$107,000.00	15%	$16,050.00	$123,050.00
	Mitigation	1	LS	$120,875.00	$120,875.00	15%	$18,131.25	$139,006.25
	Retaining Wall	1	LS	$70,265.00	$70,265.00	15%	$10,539.75	$80,804.75
	Parking Lot Repairs	1	LS	$7,610.00	$7,610.00	15%	$1,141.50	$8,751.50
	SUBTOTAL LEVEE AND FLOODWALLS				$1,978,096.90		$294,228.49	$2,272,325.39
	TOTAL ESTIMATED CONSTRUCTION COST							$2,389,650.
30	PLANNING, ENGINEERING, AND DESIGN @ 15%							$358,447.56
31	CONSTRUCTION MANAGEMENT @ 9%							$215,068.53
	TOTAL PROJECT COST							**$3,618,166.**

NOTE: Prepared by Stanley (Des Moines Metro Study, Birdland Levee, Des Moines River, July 2002); revised by MVR-ED-C. Construction costs included overhead and profit. Price Level May 2004.

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Table 2 Birdland Park Preliminary Cost Estimate 250-Year Height

Birdland Park 250-Year, Alignment 2, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
1	LANDS AND DAMAGES							
	Non-Federal	1	LS	$45,000.00	$45,000.00	0%	$0.00	$45,000.00
	Federal	1	LS	$610,000.00	$610,000.00	0%	$0.00	$610,000.00
	SUBTOTAL LANDS AND DAMAGES							$655,000.00
2	RELOCATIONS							
	Remove Waterline Guthrie Ave S	1,000	LF	$26.00	$26,000.00	15%	$3,900.00	$29,900.00
	Restore sidewalk & driveways Guthrie	3,500	SF	$6.50	$22,750.00	10%	$2,275.00	$25,025.00
	Replace Waterline Guthrie Ave N	1,000	LF	$52.00	$52,000.00	20%	$10,400.00	$62,400.00
	SUBTOTAL RELOCATIONS				$100,750.00			$117,325.00
11	LEVEES AND FLOODWALLS							
	Silt Fence	1,600	LF	$2.65	$4,240.00	15%	$636.00	$4,876.00
	Clearing and Grubbing	8.65	AC	$5,550.00	$48,007.50	15%	$7,201.13	$55,208.63
	Strip, Stockpile/Replace Topsoil	11,000	CY	$8.75	$96,250.00	15%	$14,437.50	$110,687.50
	Seeding	14	AC	$2,870.00	$40,180.00	15%	$6,027.00	$46,207.00
	Borrow, Haul Material	84,347	CY	$7.45	$628,385.15	15%	$94,257.77	$722,642.92
	Place, Shape Embankment	96,749	CY	$4.60	$445,045.40	15%	$66,756.81	$511,802.21
	Excavation/Disposal	25,300	CY	$3.65	$92,345.00	15%	$13,851.75	$106,196.75
	Bedding	1,931	TON	$29.00	$55,999.00	10%	$5,599.90	$61,598.90
	Riprap	5,363	TON	$47.75	$256,083.25	15%	$38,412.49	$294,495.74
	6th Ave Ramp Asphalt Pvmnt	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45
	6th Ave Ramp Prime Coat	267	GA	$4.90	$1,308.30	15%	$196.25	$1,504.55
	6th Ave Ramp Aggregate Base Course	677	TON	$28.65	$19,396.05	15%	$2,909.41	$22,305.46
	Signage and Striping	1	LS	$1,958.00	$1,958.00	15%	$293.70	$2,251.70
	Remove & Replace 8' Chain Link Fence	100	LF	$24.85	$2,485.00	15%	$372.75	$2,857.75
	Saylor Road Closure Structure	1	LS	$114,711.00	$114,711.00	15%	$17,206.65	$131,917.65
	Bike Path Asphalt Pavement	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45
	Bike Path Prime Coat	356	GA	$4.90	$1,744.40	15%	$261.66	$2,006.06
	Bike Path Aggregate Base Course	533	TON	$31.80	$16,949.40	15%	$2,542.41	$19,491.81
	Drainage Structure- Sta 201+00	1	LS	$32,878.00	$32,878.00	10%	$3,287.80	$36,165.80
	Drainage Structure Dewatering	1	LS	$39,156.00	$39,156.00	20%	$7,831.20	$46,987.20
	Demolish Gatewells A&B	1	LS	$13,052.00	$13,052.00	15%	$1,957.80	$15,009.80
	Reconstruct Gatewells A&B	1	LS	$35,240.00	$35,240.00	15%	$5,286.00	$40,526.00

Birdland Park 250-Year, Alignment 2, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
	Seepage Berm	20,000	CY	$5.35	$107,000.00	15%	$16,050.00	$123,050.00
	Mitigation	1	LS	$120,875.00	$120,875.00	15%	$18,131.25	$139,006.25
	Retaining Wall	1	LS	$70,265.00	$70,265.00	15%	$10,539.75	$80,804.75
	Parking Lot Repairs	1	LS	$7,610.00	$7,610.00	15%	$1,141.50	$8,751.50
	SUBTOTAL LEVEE AND FLOODWALLS				$2,279,409.45		$339,425.37	$2,618,834.82
	TOTAL ESTIMATED CONSTRUCTION COST							$2,736,160.
30	PLANNING, ENGINEERING, AND DESIGN @ 15%							$410,423.97
31	CONSTRUCTION MANAGEMENT @ 9%							$246,254.38
	TOTAL PROJECT COST							**$4,047,838.**

NOTE: Prepared by Stanley (Des Moines Metro Study, Birdland Levee, Des Moines River, July 2002); revised by MVR-ED-C. Construction costs included overhead and profit. Price Level May 2004 .

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Table 3 Birdland Park Preliminary Cost Estimate 500-Year Height

Birdland Park 500-Year, Alignment 2, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
1	LANDS AND DAMAGES							
	Non-Federal	1	LS	$45,000.00	$45,000.00	0%	$0.00	$45,000.00
	Federal	1	LS	$610,000.00	$610,000.00	0%	$0.00	$610,000.00
	SUBTOTAL LANDS AND DAMAGES							$655,000.00
2	RELOCATIONS							
	Remove Waterline Guthrie Ave S	1,000	LF	$26.00	$26,000.00	15%	$3,900.00	$29,900.00
	Restore sidewalk & driveways Guthrie	3,500	SF	$6.50	$22,750.00	10%	$2,275.00	$25,025.00
	Replace Waterline Guthrie Ave N	1,000	LF	$52.00	$52,000.00	20%	$10,400.00	$62,400.00
	SUBTOTAL RELOCATIONS				$100,750.00			$117,325.00
11	LEVEES AND FLOODWALLS							
	Silt Fence	1,600	LF	$2.65	$4,240.00	15%	$636.00	$4,876.00
	Clearing and Grubbing	9	AC	$5,550.00	$48,007.50	15%	$7,201.13	$55,208.63
	Strip, Stockpile/Replace Topsoil	11,000	CY	$8.75	$96,250.00	15%	$14,437.50	$110,687.50
	Seeding	14	AC	$2,870.00	$40,180.00	15%	$6,027.00	$46,207.00
	Borrow, Haul Material	132,740	CY	$7.45	$988,913.00	15%	$148,336.95	$1,137,249.95
	Place, Shape Embankment	145,150	CY	$4.60	$667,690.00	15%	$100,153.50	$767,843.50
	Excavation/Disposal	25,300	CY	$3.65	$92,345.00	15%	$13,851.75	$106,196.75
	Bedding	2,062	TON	$29.00	$59,798.00	10%	$5,979.80	$65,777.80
	Riprap	5,728	TON	$47.75	$273,512.00	15%	$41,026.80	$314,538.80
	6th Ave Ramp Asphalt Pvmnt	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45
	6th Ave Ramp Prime Coat	267	GA	$4.90	$1,308.30	15%	$196.25	$1,504.55
	6th Ave Ramp Aggregate Base Course	677	TON	$28.65	$19,396.05	15%	$2,909.41	$22,305.46
	Signage and Striping	1	LS	$1,958.00	$1,958.00	15%	$293.70	$2,251.70
	Remove & Replace 8' Chain Link Fence	100	LF	$24.85	$2,485.00	15%	$372.75	$2,857.75
	Saylor Road Closure Structure	1	LS	$114,711.00	$114,711.00	15%	$17,206.65	$131,917.65
	Bike Path Asphalt Pavement	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45
	Bike Path Prime Coat	356	GA	$4.90	$1,744.40	15%	$261.66	$2,006.06
	Bike Path Aggregate Base Course	533	TON	$31.80	$16,949.40	15%	$2,542.41	$19,491.81
	Drainage Structure- Sta 201+00	1	LS	$32,878.00	$32,878.00	10%	$3,287.80	$36,165.80
	Drainage Structure Dewatering	1	LS	$39,156.00	$39,156.00	20%	$7,831.20	$46,987.20
	Demolish Gatewells A&B	1	LS	$13,052.00	$13,052.00	15%	$1,957.80	$15,009.80

Birdland Park 500-Year, Alignment 2, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
	Reconstruct Gatewells A&B	1	LS	$35,240.00	$35,240.00	15%	$5,286.00	$40,526.00
	Seepage Berm	29,400	CY	$5.35	$157,290.00	15%	$23,593.50	$180,883.50
	Mitigation	1	LS	$120,875.00	$120,875.00	15%	$18,131.25	$139,006.25
	Retaining Wall	1	LS	$70,265.00	$70,265.00	15%	$10,539.75	$80,804.75
	Parking Lot Repairs	1	LS	$7,610.00	$7,610.00	15%	$1,141.50	$8,751.50
	SUBTOTAL LEVEE AND FLOODWALLS				$2,934,099.65		$437,438.95	$3,371,538.60
	TOTAL ESTIMATED CONSTRUCTION COST							$3,488,864.
30	PLANNING, ENGINEERING, AND DESIGN @ 15%							$523,329.54
31	CONSTRUCTION MANAGEMENT @ 9%							$313,997.72
	TOTAL PROJECT COST							**$4,981,191.**

NOTE: Prepared by Stanley (Des Moines Metro Study, Birdland Levee, Des Moines River, July 2002); revised by MVR-ED-C. Construction costs included overhead and profit. Price Level May 2004.

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Table 4 Central Place Preliminary Cost Estimate 100-Year Height

Central Place 100-Year, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
1	LANDS AND DAMAGES							
	Non-Federal	1	JOB	SUM	$134,500.00	0%	$0.00	$134,500.00
	Federal	1	JOB	SUM	$29,000.00	0%	$0.00	$29,000.00
	SUBTOTAL LANDS AND DAMAGES				$163,500.00			$163,500.00
11	LEVEES AND FLOODWALLS							
	Clearing and Grubbing	70,000	SY	$1.05	$73,500.00	15%	$11,025.00	$84,525.00
	Stripping	70,000	SY	$0.40	$28,000.00	15%	$4,200.00	$32,200.00
	Embankment Foundation Preparation	490	MSF	$14.60	$7,154.00	15%	$1,073.10	$8,227.00
	Levee Embankment Cut/Fill	22,300	CY	$4.90	$109,270.00	15%	$16,390.50	$125,661.00
	Relocate/Shape/Place Imprv Embankment	59,840	CY	$8.50	$508,640.00	15%	$76,296.00	$584,936.00
	Removal of Overburden	16,670	CY	$4.90	$81,683.00	15%	$12,252.45	$93,935.00
	Borrow	17,300	CY	$7.25	$125,425.00	15%	$18,813.75	$144,239.00
	Haul Excess Material	3,000	CY	$8.15	$24,450.00	15%	$3,667.50	$28,118.00
	Relocate Existing Concrete Rubble	1,000	CY	$8.20	$8,200.00	15%	$1,230.00	$9,430.00
	Seeding of Disturbed Areas	70,000	SY	$0.70	$49,000.00	15%	$7,350.00	$56,350.00
	Bedding	1,300	TON	$29.25	$38,025.00	10%	$3,802.50	$41,828.00
	Riprap	4,200	TON	$48.00	$201,600.00	10%	$20,160.00	$221,760.00
	New Gatewell - Sta 11+26	1	JOB	SUM	$67,303.00	20%	$13,460.60	$80,764.00
	New Gatewell - Sta 68+20	1	JOB	SUM	$50,477.00	20%	$10,095.40	$60,572.00
	Relocation of Electrical	1	JOB	SUM	$37,041.00	20%	$7,408.20	$44,449.00
	Mitigation - Tree Planting	1	JOB	SUM	$89,696.00	15%	$13,454.40	$103,150.00
	SUBTOTAL LEVEE AND FLOODWALLS				$1,499,464.00			$1,720,144.00
13	PUMP STATIONS							
	Pump Station Modification - Indiana							
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00
	Structural Modifications	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$9,173.00	15%	$1,375.95	$10,549.00
	New Discharge Pipes	1	JOB	SUM	$13,688.00	20%	$2,737.60	$16,426.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00

Central Place 100-Year, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$36,113.00	15%	$5,416.95	$41,530.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Indiana				*$194,408.00*			*$224,884.00*
	Pump Station Modification - Franklin							
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00
	Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$8,125.00	15%	$1,218.75	$9,344.00
	New Discharge Pipes	1	JOB	SUM	$10,777.00	20%	$2,155.40	$12,932.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$35,066.00	15%	$5,259.90	$40,326.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Franklin				*$189,402.00*			*$218,981.00*
	Pump Station Modification - Clark							
	Excavation/Pipe Removal	1	JOB	SUM	$21,941.00	15%	$3,291.15	$25,232.00
	Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$11,022.00	15%	$1,653.30	$12,675.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$7,884.00	15%	$1,182.60	$9,067.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$10,655.00	15%	$1,598.25	$12,253.00
	New Discharge Pipes	1	JOB	SUM	$23,146.00	20%	$4,629.20	$27,775.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$39,586.00	15%	$5,937.90	$45,524.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Clark				*$215,336.00*			*$249,423.00*
	SUBTOTAL PUMP STATIONS				$599,146.00			$693,288.00

Central Place 100-Year, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
	Total Estimated Construction Cost							$2,413,432.
30	PLANNING, ENGINEERING, AND DESIGN @ 15%							$362,015.00
31	CONSTRUCTION MANAGEMENT @ 9%							$217,209.00
	Total Project Cost							**$3,156,156.**

NOTE: Prepared by MVR-ED-C. Construction costs include overhead and profit. Price Level May 2004.

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Table 5 Central Place Preliminary Cost Estimate 250-Year Height

Central Place 250-Year, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
1	LANDS AND DAMAGES							
	Non-Federal	1	JOB	SUM	$134,500.00	0%	$0.00	$134,500.00
	Federal	1	JOB	SUM	$29,000.00	0%	$0.00	$29,000.00
	SUBTOTAL LANDS AND DAMAGES				$163,500.00			$163,500.00
11	LEVEES AND FLOODWALLS							
	Clearing and Grubbing	70,000	SY	$1.05	$73,500.00	15%	$11,025.00	$84,525.00
	Stripping	70,000	SY	$0.40	$28,000.00	15%	$4,200.00	$32,200.00
	Embankment Foundation Preparation	490	MSF	$14.60	$7,154.00	15%	$1,073.10	$8,227.00
	Levee Embankment Cut/Fill	22,300	CY	$4.90	$109,270.00	15%	$16,390.50	$125,661.00
	Relocate/Shape/Place Imprv Embankment	68,920	CY	$8.50	$585,820.00	15%	$87,873.00	$673,693.00
	Removal of Overburden	38,660	CY	$4.90	$189,434.00	15%	$28,415.10	$217,849.00
	Borrow	17,300	CY	$7.25	$125,425.00	15%	$18,813.75	$144,239.00
	Haul Excess Material	3,000	CY	$8.15	$24,450.00	15%	$3,667.50	$28,118.00
	Relocate Existing Concrete Rubble	1,000	CY	$8.20	$8,200.00	15%	$1,230.00	$9,430.00
	Seeding of Disturbed Areas	70,000	SY	$0.70	$49,000.00	15%	$7,350.00	$56,350.00
	Bedding	1,300	TON	$29.25	$38,025.00	10%	$3,802.50	$41,828.00
	Riprap	4,200	TON	$48.00	$201,600.00	10%	$20,160.00	$221,760.00
	New Gatewell - Sta 11+26	1	JOB	SUM	$67,303.00	20%	$13,460.60	$80,764.00
	New Gatewell - Sta 68+20	1	JOB	SUM	$50,477.00	20%	$10,095.40	$60,572.00
	Relocation of Electrical	1	JOB	SUM	$37,041.00	20%	$7,408.20	$44,449.00
	Mitigation - Tree Planting	1	JOB	SUM	$89,696.00	15%	$13,454.40	$103,150.00
	SUBTOTAL LEVEE AND FLOODWALLS				$1,684,395.00			$1,932,815.00
13	PUMP STATIONS							
	Pump Station Modification - Indiana							
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00
	Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$9,173.00	15%	$1,375.95	$10,549.00
	New Discharge Pipes	1	JOB	SUM	$13,688.00	20%	$2,737.60	$16,426.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00

Central Place 250-Year, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$36,113.00	15%	$5,416.95	$41,530.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification – Indiana				*$194,408.00*			*$224,884.00*
	Pump Station Modification - Franklin							
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00
	Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$8,125.00	15%	$1,218.75	$9,344.00
	New Discharge Pipes	1	JOB	SUM	$10,777.00	20%	$2,155.40	$12,932.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$35,066.00	15%	$5,259.90	$40,326.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification – Franklin				*$189,402.00*			*$218,981.00*
	Pump Station Modification - Clark							
	Excavation/Pipe Removal	1	JOB	SUM	$21,941.00	15%	$3,291.15	$25,232.00
	Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$11,022.00	15%	$1,653.30	$12,675.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$7,884.00	15%	$1,182.60	$9,067.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$10,655.00	15%	$1,598.25	$12,253.00
	New Discharge Pipes	1	JOB	SUM	$23,146.00	20%	$4,629.20	$27,775.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$39,586.00	15%	$5,937.90	$45,524.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Clark				*$215,336.00*			*$249,423.00*
	SUBTOTAL PUMP STATIONS				$599,146.00			$693,288.00

Central Place 250-Year, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
	Total Estimated Construction Cost							$2,626,103.
30	PLANNING, ENGINEERING AND DESIGN @ 15%							$393,915.00
31	CONSTRUCTION MANAGEMENT @ 9%							$236,349.00
	Total Project Cost							**$3,419,867.**

NOTE: Prepared by MVR-ED-C. Construction costs include overhead and profit. Price Level May 2004.

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Table 6 Central Place Preliminary Cost Estimate 500-Year Height

Central Place 500-Year, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
1	LANDS AND DAMAGES							
	Non-Federal	1	JOB	SUM	$134,500.00	0%	$0.00	$134,500.00
	Federal	1	JOB	SUM	$29,000.00	0%	$0.00	$29,000.00
	SUBTOTAL LANDS AND DAMAGES				$163,500.00			$163,500.00
11	LEVEES AND FLOODWALLS							
	Clearing and Grubbing	70,000	SY	$1.05	$73,500.00	15%	$11,025.00	$84,525.00
	Stripping	70,000	SY	$0.40	$28,000.00	15%	$4,200.00	$32,200.00
	Embankment Foundation Preparation	490	MSF	$14.60	$7,154.00	15%	$1,073.10	$8,227.00
	Levee Embankment Cut/Fill	22,300	CY	$4.90	$109,270.00	15%	$16,390.50	$125,661.00
	Relocate/Shape/Place Embankment	81,600	CY	$8.50	$693,600.00	15%	$104,040.00	$797,640.00
	Removal of Overburden	30,330	CY	$4.90	$148,617.00	15%	$22,292.55	$170,910.00
	Levee Tie-off at University Avenue	1	JOB	SUM	$6,705.00	20%	$1,341.00	$8,046.00
	Borrow	17,300	CY	$7.25	$125,425.00	15%	$18,813.75	$144,239.00
	Haul Excess Material	3,000	CY	$8.15	$24,450.00	15%	$3,667.50	$28,118.00
	Relocate Existing Concrete Rubble	1,000	CY	$8.20	$8,200.00	15%	$1,230.00	$9,430.00
	Seeding of Disturbed Areas	70,000	SY	$0.70	$49,000.00	15%	$7,350.00	$56,350.00
	Bedding	1,300	TON	$29.25	$38,025.00	10%	$3,802.50	$41,828.00
	Riprap	4,200	TON	$48.00	$201,600.00	10%	$20,160.00	$221,760.00
	New Gatewell - Sta 11+26	1	JOB	SUM	$67,303.00	20%	$13,460.60	$80,764.00
	New Gatewell - Sta 68+20	1	JOB	SUM	$50,477.00	20%	$10,095.40	$60,572.00
	Relocation of Electrical	1	JOB	SUM	$37,041.00	20%	$7,408.20	$44,449.00
	Mitigation - Tree Planting	1	JOB	SUM	$88,500.00	15%	$13,275.00	$101,775.00
	SUBTOTAL LEVEE AND FLOODWALLS				$1,756,867.00			$2,016,494.00
13	PUMP STATIONS							
	Pump Station Modification - Indiana							
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00
	Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$9,173.00	15%	$1,375.95	$10,549.00
	New Discharge Pipes	1	JOB	SUM	$13,688.00	20%	$2,737.60	$16,426.00

Central Place 500-Year, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$36,113.00	15%	$5,416.95	$41,530.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Indiana				*$194,408.00*			*$224,884.00*
	Pump Station Modification - Franklin							
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00
	Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$8,125.00	15%	$1,218.75	$9,344.00
	New Discharge Pipes	1	JOB	SUM	$10,777.00	20%	$2,155.40	$12,932.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$35,066.00	15%	$5,259.90	$40,326.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Franklin				*$189,402.00*			*$218,981.00*
	Pump Station Modification - Clark							
	Excavation/Pipe Removal	1	JOB	SUM	$21,941.00	15%	$3,291.15	$25,232.00
	Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00
	Backfill/Compaction	1	JOB	SUM	$11,022.00	15%	$1,653.30	$12,675.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$7,884.00	15%	$1,182.60	$9,067.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$10,655.00	15%	$1,598.25	$12,253.00
	New Discharge Pipes	1	JOB	SUM	$23,146.00	20%	$4,629.20	$27,775.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00
	Construct New Headwall	1	JOB	SUM	$39,586.00	15%	$5,937.90	$45,524.00
	Bedding	200	TON	$29.25	$5,850.00	10%	$585.00	$6,435.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00
	Subtotal Pump Station Modification - Clark				*$215,336.00*			*$249,423.00*

Central Place 500-Year, Des Moines and Raccoon Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.
	Pump Station Modification - 2nd Avenue[1]							
	Lengthen Discharge Pipes	1	JOB	SUM	$4,890.00	20%	$978.00	$5,868.00
	New Submersible Pumps	3	EA	$68,580.00	$205,740.00	20%	$41,148.00	$246,888.00
	Subtotal Pump Station - 2nd Avenue				*$210,630.00*			*$252,756.00*
	SUBTOTAL PUMP STATIONS				$809,776.00			$946,044.00
	Total Estimated Construction Cost							$2,962,538.
30	PLANNING, ENGINEERING, AND DESIGN @ 15%							$444,381.00
31	CONSTRUCTION MANAGEMENT @ 9%							$266,628.00
	Total Project Cost							**$3,837,047.**

NOTE: Prepared by MVR-ED-C. Construction costs include overhead and profit. Price Level May 2004.
[1] No modifications were required at the 2nd Avenue Pump Station for the 100-year and 250-year protection elevations.

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Table 7 Downtown East, South, and West Preliminary Cost Estimates Closures

Downtown Reaches Preliminary Cost Estimates for Permanent Closures

Accnt Code	Item Description	Qty.	Unit of Meas.	~~Unit Cost~~	Total	Cont %	Contingency Amount	Total Cost With Contg.
11	LEVEES AND FLOODWALLS							
	Downtown East							
	Tie to I-235	1	LS		$112,171.00	25%	$28,042.75	$140,213.75
	Amphitheater Mods	1	LS		$44,667.00	50%	$22,333.50	$67,000.50
	RR 1st South Court Avenue	1	LS		$3,504.00	50%	$1,752.00	$5,256.00
	RR 2nd South Court Avenue	1	LS		$7,757.00	50%	$3,878.50	$11,635.50
	Grand Avenue East	1	LS		$26,376.00	25%	$6,594.00	$32,970.00
	Locust Street East	1	LS		$17,681.00	25%	$4,420.25	$22,101.25
	Walnut Street South	1	LS		$35,000.00	25%	$8,750.00	$43,750.00
	Court Avenue North	1	LS		$21,490.00	25%	$5,372.50	$26,862.50
	Court Avenue South	1	LS		$21,490.00	25%	$5,372.50	$26,862.50
	Downtown East RR Closure	1	LS		$5,879.00	50%	$2,939.50	$8,818.50
	RR Closure DM #41	1	LS		$2,167.00	50%	$1,083.50	$3,250.50
	DM Closure 51 Vandalia Road	1	LS		$45,724.00	25%	$11,431.00	$57,155.00
	SUBTOTAL DOWNTOWN EAST							$445,876.00
	Downtown South							
	DM #42	1	LS		$4,626.00	50%	$2,313.00	$6,939.00
	DM #36	1	LS		$5,750.00	50%	$2,875.00	$8,625.00
	SUBTOTAL DOWNTOWN SOUTH							$15,564.00
	Downtown West							
	2nd RR South of Court	1	LS		$3,125.00	50%	$1,562.50	$4,687.50
	1st RR South of Court	1	LS		$7,526.00	50%	$3,763.00	$11,289.00
	Grand Avenue	1	LS		$46,756.00	25%	$11,689.00	$58,445.00
	Walnut Street	1	LS		$22,215.00	25%	$5,553.75	$27,768.75
	East Locust Street	1	LS		$20,879.00	25%	$5,219.75	$26,098.75
	Court Avenue	1	LS		$38,294.00	25%	$9,573.50	$47,867.50
	SUBTOTAL DOWNTOWN WEST							$176,156.50
	Total Estimated Construction Cost							$637,597.

Downtown Reaches Preliminary Cost Estimates for Permanent Closures

Accnt Code	Item Description	Qty.	Unit of Meas.	~~Unit Cost~~	Total	Cont %	Contingency Amount	Total Cost With Contg.
30	PLANNING, ENGINEERING, AND DESIGN @ 30%							$191,279.00
31	CONSTRUCTION MANAGEMENT @12%							$76,512.00
	Total Project Cost							**$905,388.**

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Table 8 MCACES Cost Estimate, Birdland Park 500-Year

Birdland 500 YR-Algn 2
Des Moines and Raccoon Rivers,
Polk County, Iowa

DACW25-XX-B-XXXX

Designed By: CEMVR-ED-DM/Stanley
Estimated By: Based in part on Stanley's estimate as noted Along with additional estimating by MVR-ED-C (See notes indicating originator)
Prepared By: CEMVR-ED-C (Terri Kirkeeng) POC: T. Kirkeeng 309-794-5425

Preparation Date: 05/24/04
Effective Date of Pricing: 05/24/04

Sales Tax: 7.00%

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Tue 25 May 2004 — Tri-Service Automated Cost Engineering System (TRACES) — TIME 08:31:08
Eff. Date 05/24/04 — PROJECT BRFBCR: Birdland 500 YR-Algn 2 - Des Moines and Raccoon Rivers, Rock Island District — SUMMARY PAGE 1
** PROJECT OWNER SUMMARY - Contract **

	QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01 Birdland 500 YR, Alignmnt 2		4,529,464	454,280	441,772	5,425,516
TOTAL Birdland 500 YR-Algn 2		4,529,464	454,280	441,772	5,425,516

LABOR ID: CNTRPJ EQUIP ID: RG0599 — Currency in DOLLARS — CREW ID: NAT01A UPB ID: UP01EA

Tue 25 May 2004 — Tri-Service Automated Cost Engineering System (TRACES) — TIME 08:31:08
Eff. Date 05/24/04 — PROJECT BRFBCR: Birdland 500 YR-Algn 2 - Des Moines and Raccoon Rivers, Rock Island District — SUMMARY PAGE 2
** PROJECT OWNER SUMMARY - Bid Item **

	QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01 Birdland 500 YR, Alignmnt 2					
01. 01 Lands and Damages		655,000	0	0	655,000
01. 02 Relocations		101,153	16,641	12,969	130,763
01. 11 Levees and Floodwalls		2,935,486	437,639	371,381	3,744,506
01. 30 Planning, Engineering, Design		523,640	0	22,831	546,471
01. 31 Construction Mgmnt		314,185	0	34,592	348,777
TOTAL Birdland 500 YR, Alignmnt 2		4,529,464	454,280	441,772	5,425,516
TOTAL Birdland 500 YR-Algn 2		4,529,464	454,280	441,772	5,425,516

LABOR ID: CNTRPJ EQUIP ID: RG0599 — Currency in DOLLARS — CREW ID: NAT01A UPB ID: UP01EA

			QUANTITY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01	Birdland 500 YR, Algnmnt 2							
01.	01	Lands and Damages						
01.	01. 1	Lands and Damages-Fed			45,000	0	0	45,000
01.	01.2	Lands and Damages-Non-Fed			610,000	0	0	610,000
	TOTAL	Lands and Damages			655,000	0	0	655,000
01.	02	Relocations						
01.	02. 1	Remove Waterline Guthrie Ave S	1000.00	LF	26,104	3,916	3,305	33,324
01.	02. 3	Restore sidewalk and driveways G	3500.00	SF	22,841	2,284	2,766	27,891
01.	02.2	Replace Waterline Guthrie Ave N	1000.00	LF	52,208	10,442	6,898	69,547
	TOTAL	Relocations			101,153	16,641	12,969	130,763
01.	11	Levees and Floodwalls						
01.	11. 1	Silt Fence	1600.00	LF	4,204	631	532	5,367
01.	11. 2	Clearing and Grubbing	8.65	AC	47,982	7,197	6,075	61,255
01.	11. 3	Strip, Stockpile/Replace Topsoil	11000.00	CY	96,209	14,431	12,182	122,822
01.	11. 4	Seeding	14.00	AC	40,141	6,021	5,082	51,244
01.	11. 5	Borrow	132740.00	CY	990,569	148,585	125,421	1,264,575
01.	11. 6	Place, Shape Embankment	145150.00	CY	668,844	100,327	84,686	853,856
01.	11. 7	Excavation and Disposal	25300.00	CY	91,972	13,796	11,645	117,413
01.	11. 8	Bedding	2062.00	TN	59,964	5,996	7,262	73,223
01.	11. 9	Riprap	5728.00	TN	273,495	41,024	34,629	349,148
01.	11.12	Signage and Striping			1,958	294	248	2,499
01.	11.13	Remove/Replace Chain L Fence	100.00	LF	2,485	373	315	3,173
01.	11.14	Saylor Rd Closure Structure			114,711	17,207	14,524	146,442
01.	11.15	Drainage Structure Sta 201+00			32,878	3,288	3,982	40,147
01.	11.16	Demolish Gatewells A&B			13,052	1,958	1,653	16,662
01.	11.17	Reconstruct Gatewells A &B			35,240	5,286	4,462	44,988
01.	11.18	Seepage Berm	29400.00	CY	156,251	23,438	19,784	199,472
02.	11.19	Drge Strctr Sta 201+00 Dewaterin			39,156	7,831	5,173	52,160
01.	11.20	6th Ave Ramp Asphalt	290.00	TN	14,124	2,119	1,788	18,031
01.	11.21	6th Ave Ramp Prime Coat	267.00	GA	1,303	195	165	1,664
01.	11.22	6th Ave Agg Base Course	677.00	TN	19,401	2,910	2,456	24,767
01.	11.23	Bike Path Asphalt	290.00	TN	14,124	2,119	1,788	18,031
01.	11.24	Bike Path Prime Coat	356.00	GA	1,738	261	220	2,219
01.	11.25	Bike Path Agg Base Course	533.00	TN	16,947	2,542	2,146	21,635
01.	11.27	Parking Lot Repairs			7,607	1,141	963	9,711
01.	11.29	Mitigation			120,871	18,131	15,304	154,306
01.	11.30	Segmental Retaining Wall	450.00	LF	70,261	10,539	8,896	89,696
	TOTAL	Levees and Floodwalls			2,935,486	437,639	371,381	3,744,506

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		QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01.	30 Planning, Engineering, Design					
01.	30.10 PED		523,640	0	22,831	546,471
	TOTAL Planning, Engineering, Design		523,640	0	22,831	546,471
01.	31 Construction Mgmnt					
01.	31.10 Construction Management		314,185	0	34,592	348,777
	TOTAL Construction Mgmnt		314,185	0	34,592	348,777
	TOTAL Birdland 500 YR, Algnmnt 2		4,529,464	454,280	441,772	5,425,516
	TOTAL Birdland 500 YR-Align 2		4,529,464	454,280	441,772	5,425,516

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		QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01	Birdland 500 YR, Alignmnt 2					
01.	01 Lands and Damages					
01.	01.1 Lands and Damages-Fed		45,000	0	0	45,000
01.	01.2 Lands and Damages-Non-Fed		610,000	0	0	610,000
	TOTAL Lands and Damages		655,000	0	0	655,000
01.	02 Relocations					
01.	02.1 Remove Waterline Guthrie Ave S	1000.00 LF	26,104	3,916	3,305	33,324
01.	02.3 Restore Sidewalk and driveways G	3500.00 SF	22,841	2,284	2,766	27,891
01.	02.2 Replace Waterline Guthrie Ave N	1000.00 LF	52,208	10,442	6,898	69,547
	TOTAL Relocations		101,153	16,641	12,969	130,763
01.	11 Levees and Floodwalls					
01.	11.1 Silt Fence	1600.00 LF	4,204	631	532	5,367
01.	11.2 Clearing and Grubbing	8.65 AC	47,982	7,197	6,075	61,255
01.	11.3 Strip, Stockpile/Replace Topsoil	11000.00 CY	96,209	14,431	12,182	122,822
01.	11.4 Seeding					
01.	11.4.1 Seeding of Disturbed Areas		40,141	6,021	5,082	51,244
	TOTAL Seeding	14.00 AC	40,141	6,021	5,082	51,244
01.	11.5 Borrow					
01.	11.5.5 Load Borrow	159288.00 CY	285,261	42,789	36,118	364,169
01.	11.5.10 Haul Material	159288.00 CY	705,307	105,796	89,302	900,406
	TOTAL Borrow	132740.00 CY	990,569	148,585	125,421	1,264,575
01.	11.6 Place, Shape Embankment					
01.	11.6.1 Embankment Foundation Prep	950.00 MSF	13,816	2,072	1,749	17,638
01.	11.6.2 Place And Compact Embankment	145150.00 CY	655,028	98,254	82,936	836,219
	TOTAL Place, Shape Embankment	145150.00 CY	668,844	100,327	84,686	853,856
01.	11.7 Excavation and Disposal	25300.00 CY	91,972	13,796	11,645	117,413
01.	11.8 Bedding					

			QUANTITY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01.	11. 8. 5	Bedding, 3601 Ton	2062.00	TN	45,243	4,524	5,479	55,246
01.	11. 8.10	Haul Bedding From Rail Yard	2062.00	TN	14,721	1,472	1,783	17,977
		TOTAL Bedding	2062.00	TN	59,964	5,996	7,262	73,223
01.	11. 9	Riprap						
01.	11. 9. 5	Riprap	5728.00	TN	232,601	34,890	29,451	296,942
01.	11. 9.10	Hauling Riprap From Rail Yard	5728.00	TN	40,895	6,134	5,178	52,207
		TOTAL Riprap	5728.00	TN	273,495	41,024	34,629	349,148
01.	11.12	Signage and Striping			1,958	294	248	2,499
01.	11.13	Remove/Replace Chain L Fence	100.00	LF	2,485	373	315	3,173
01.	11.14	Saylor Rd Closure Structure			114,711	17,207	14,524	146,442
01.	11.15	Drainage Structure Sta 201+00			32,878	3,288	3,982	40,147
01.	11.16	Demolish Gatewells A&B			13,052	1,958	1,653	16,662
01.	11.17	Reconstruct Gatewells A &B			35,240	5,286	4,462	44,988
01.	11.18	Seepage Berm						
01.	11.18. 1	Material Costs			38,940	5,841	4,930	49,712
01.	11.18. 2	Placement of Material			117,310	17,597	14,853	149,760
		TOTAL Seepage Berm	29400.00	CY	156,251	23,438	19,784	199,472
01.	11.19	Drge Strctr Sta 201+00 Dewaterin			39,156	7,831	5,173	52,160
01.	11.20	6th Ave Ramp Asphalt	290.00	TN	14,124	2,119	1,788	18,031
01.	11.21	6th Ave Ramp Prime Coat	267.00	GA	1,303	195	165	1,664
01.	11.22	6th Ave Agg Base Course	677.00	TN	19,401	2,910	2,456	24,767
01.	11.23	Bike Path Asphalt	290.00	TN	14,124	2,119	1,788	18,031
01.	11.24	Bike Path Prime Coat	356.00	GA	1,738	261	220	2,219
01.	11.25	Bike Path Agg Base Course	533.00	TN	16,947	2,542	2,146	21,635
01.	11.27	Parking Lot Repairs						
01.	11.27. 5	Removal of Parking Lot			1,746	262	221	2,229
01.	11.27.10	Replacement of ACC			5,861	879	742	7,482
		TOTAL Parking Lot Repairs			7,607	1,141	963	9,711
01.	11.29	Mitigation						
01.	11.29. 5	Excavation/Construct Wetlands			46,592	6,989	5,899	59,480
01.	11.29.10	Spoil Placement Site Prep			2,095	314	265	2,675
01.	11.29.15	Seeding/Planting			39,488	5,923	5,000	50,411
01.	11.29.20	Upland Tree Plantings			17,002	2,550	2,153	21,704
01.	11.29.25	Bottomland Tree Plantings			2,616	392	331	3,339
01.	11.29.30	Shrub Plantings			9,340	1,401	1,183	11,923

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			QUANTITY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01.	11.29.35	Mob & Demob			3,739	561	473	4,773
		TOTAL Mitigation			120,871	18,131	15,304	154,306
01.	11.30	Segmental Retaining Wall						
01.	11.30. 5	Segmental Retaining Wall	450.00	LF	70,261	10,539	8,896	89,696
		TOTAL Segmental Retaining Wall	450.00	LF	70,261	10,539	8,896	89,696
		TOTAL Levees and Floodwalls			2,935,486	437,639	371,381	3,744,506
01.	30	Planning, Engineering, Design						
01.	30.10	PED						
01.	30.10. 5	PED			523,640	0	22,831	546,471
		TOTAL PED			523,640	0	22,831	546,471
		TOTAL Planning, Engineering, Design			523,640	0	22,831	546,471
01.	31	Construction Mgmnt						
01.	31.10	Construction Management						
01.	31.10. 5	Construction Management			314,185	0	34,592	348,777
		TOTAL Construction Management			314,185	0	34,592	348,777
		TOTAL Construction Mgmnt			314,185	0	34,592	348,777
		TOTAL Birdland 500 YR. Alignmnt 2			4,529,464	454,280	441,772	5,425,516
		TOTAL Birdland 500 YR-Algn 2			4,529,464	454,280	441,772	5,425,516

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Table 9 MCACES Cost Estimate, Birdland Park Recreation

LABOR ID: CNTRPJ EQUIP ID: RG0599 Currency in DOLLARS CREW ID: NAT01A UPB ID: UP01EA

Tue 25 May 2004 Tri-Service Automated Cost Engineering System (TRACES) TIME 09:40:33
Eff. Date 05/24/04 PROJECT BRTRAL: Birdland Recreation - Des Moines and Raccoon Rivers, TITLE PAGE 1
Rock Island District

Birdland Recreation
Des Moines and Raccoon Rivers,
Polk County, Iowa

Designed By: CEMVR-ED-C
Estimated By:

Prepared By: CEMVR-ED-C (T. Kirkeeng)
POC: T. Kirkeeng, 309-794-5425

Preparation Date: 05/24/04
Effective Date of Pricing: 05/24/04

Sales Tax: 7.00%

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LABOR ID: CNTRPJ EQUIP ID: RG0599 Currency in DOLLARS CREW ID: NAT01A UPB ID: UP01EA

Tue 25 May 2004 — Tri-Service Automated Cost Engineering System (TRACES) — TIME 09:40:33
Eff. Date 05/24/04
PROJECT BRTRAL: Birdland Recreation - Des Moines and Raccoon Rivers, Rock Island District — SUMMARY PAGE 1
** PROJECT OWNER SUMMARY - Contract **

	QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01 Birdland Recreation		215,966	25,387	24,631	265,984
TOTAL Birdland Recreation		215,966	25,387	24,631	265,984

LABOR ID: CNTRRJ EQUIP ID: RG0599 — Currency in DOLLARS — CREW ID: NAT01A UPB ID: UP01EA

Tue 25 May 2004 — Tri-Service Automated Cost Engineering System (TRACES) — TIME 09:40:33
Eff. Date 05/24/04
PROJECT BRTRAL: Birdland Recreation - Des Moines and Raccoon Rivers, Rock Island District — SUMMARY PAGE 2
** PROJECT OWNER SUMMARY - Bid Item **

	QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01 Birdland Recreation					
01. 14 Recreational Facilities		169,246	25,387	21,429	216,062
01. 30 Planning, Engineering, Design		29,200	0	1,273	30,473
01. 31 Construction Mgmnt		17,520	0	1,929	19,449
TOTAL Birdland Recreation		215,966	25,387	24,631	265,984
TOTAL Birdland Recreation		215,966	25,387	24,631	265,984

LABOR ID: CNTRRJ EQUIP ID: RG0599 — Currency in DOLLARS — CREW ID: NAT01A UPB ID: UP01EA

		QUANTITY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01	Birdland Recreation						
01.	14 Recreational Facilities						
01.	14. 4 Seeding	0.50	AC	1,309	196	166	1,671
01.	14. 5 Borrow	7700.00	CY	57,230	8,584	7,246	73,060
01.	14. 6 Place, Shape Material	7700.00	CY	36,689	5,503	4,645	46,838
01.	14.10 Shoulders	490.00	CY	18,046	2,707	2,285	23,038
01.	14.20 ACC Surfacing	560.00	TN	27,273	4,091	3,453	34,818
01.	14.24 Path Prime Coat	356.00	GA	2,058	309	261	2,627
01.	14.25 Aggregate Base	930.00	TN	26,641	3,996	3,373	34,010
	TOTAL Recreational Facilities			169,246	25,387	21,429	216,062
01.	30 Planning, Engineering, Design						
01.	30.10 PED			29,200	0	1,273	30,473
	TOTAL Planning, Engineering, Design			29,200	0	1,273	30,473
01.	31 Construction Mgmnt						
01.	31.10 Construction Management			17,520	0	1,929	19,449
	TOTAL Construction Mgmnt			17,520	0	1,929	19,449
	TOTAL Birdland Recreation			215,966	25,387	24,631	265,984
	TOTAL Birdland Recreation			215,966	25,387	24,631	265,984

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		QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01	Birdland Recreation					
01. 14	Recreational Facilities					
01. 14. 4	Seeding					
01. 14. 4. 1	Seeding of Disturbed Areas		1,309	196	166	1,671
	TOTAL Seeding	0.50 AC	1,309	196	166	1,671
01. 14. 5	Borrow					
01. 14. 5. 5	Load Borrow	9240.00 CY	16,316	2,447	2,066	20,830
01. 14. 5.10	Haul Material	9240.00 CY	40,914	6,137	5,180	52,231
	TOTAL Borrow	7700.00 CY	57,230	8,584	7,246	73,060
01. 14. 6	Place, Shape Material					
01. 14. 6. 1	Embankment Foundation Prep	950.00 MSF	457	68	58	583
01. 14. 6. 2	Place And Compact Embankment	7700.00 CY	36,232	5,435	4,588	46,255
	TOTAL Place, Shape Material	7700.00 CY	36,689	5,503	4,645	46,838
01. 14.10	Shoulders	490.00 CY	18,046	2,707	2,285	23,038
01. 14.20	ACC Surfacing	560.00 TN	27,273	4,091	3,453	34,818
01. 14.24	Path Prime Coat	356.00 GA	2,058	309	261	2,627
01. 14.25	Aggregate Base	930.00 TN	26,641	3,996	3,373	34,010
	TOTAL Recreational Facilities		169,246	25,387	21,429	216,062
01. 30	Planning, Engineering, Design					
01. 30.10	PED					
01. 30.10. 5	PED		29,200	0	1,273	30,473
	TOTAL PED		29,200	0	1,273	30,473
	TOTAL Planning, Engineering, Design		29,200	0	1,273	30,473
01. 31	Construction Mgmnt					
01. 31.10	Construction Management					

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	QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01. 31.10. 5 Construction Management		17,520	0	1,929	19,449
TOTAL Construction Management		17,520	0	1,929	19,449
TOTAL Construction Mgmnt		17,520	0	1,929	19,449
TOTAL Birdland Recreation		215,966	25,387	24,631	265,984
TOTAL Birdland Recreation		215,966	25,387	24,631	265,984

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Table 10 MCACES Cost Estimate, Central Place 500-Year Levee

Tue 25 May 2004
Eff. Date 05/24/04

Tri-Service Automated Cost Engineering System (TRACES)
PROJECT CPFBCR: Central Place - 500 YR - Des Moines and Raccoon Rivers, Rock Island District

TIME 09:35:13
TITLE PAGE 1

Central Place - 500 YR
Des Moines and Raccoon Rivers,
Polk County, Iowa

DACW25-XX-B-XXXX

Designed By: CEMVR-ED-DF
Estimated By:

Prepared By: CEMVR-ED-C (T. Kirkeeng)
POC: T. Kirkeeng, 309-794-5425

Preparation Date: 05/24/04
Effective Date of Pricing: 05/24/04

Sales Tax: 7.0%

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Release 1.2

LABOR ID: CNTRPJ EQUIP ID: RG0599 Currency in DOLLARS CREW ID: NAT01A UPB ID: UP01EA

Tue 25 May 2004 — Tri-Service Automated Cost Engineering System (TRACES) — TIME 09:35:13
Eff. Date 05/24/04 — PROJECT CPFBCR: Central Place - 500 YR - Des Moines and Raccoon Rivers, Rock Island District — SUMMARY PAGE 1
** PROJECT OWNER SUMMARY - Contract **

	QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
10 Central Place - 500 YR		3,442,305	396,036	375,036	4,213,377
TOTAL Central Place - 500 YR		3,442,305	396,036	375,036	4,213,377

LABOR ID: CNTRPJ EQUIP ID: RG0599 — Currency in DOLLARS — CREW ID: NAT01A UPB ID: UP01EA

Tue 25 May 2004 — Tri-Service Automated Cost Engineering System (TRACES) — TIME 09:35:13
Eff. Date 05/24/04 — PROJECT CPFBCR: Central Place - 500 YR - Des Moines and Raccoon Rivers, Rock Island District — SUMMARY PAGE 2
** PROJECT OWNER SUMMARY - Bid Item **

	QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
10 Central Place - 500 YR					
10. 01 Lands and Damages		163,500	0	0	163,500
10. 11 Levees and Floodwalls		1,757,698	259,763	222,121	2,239,582
10. 13 Pump Station Mod - Indiana		194,431	30,478	24,762	249,671
10. 30 Planning, Engineering, Design		444,550	0	19,382	463,932
10. 31 Construction Management		266,725	0	29,366	296,091
10. 74 Pump Station Mod - Franklin		189,425	29,581	24,113	243,119
10. 75 Pump Station Mod - Clark		215,359	34,090	27,464	276,914
10. 76 Pump Station Mod -2nd Ave		210,618	42,124	27,827	280,568
TOTAL Central Place - 500 YR		3,442,305	396,036	375,036	4,213,377
TOTAL Central Place - 500 YR		3,442,305	396,036	375,036	4,213,377

LABOR ID: CNTRPJ EQUIP ID: RG0599 — Currency in DOLLARS — CREW ID: NAT01A UPB ID: UP01EA

			QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
10		Central Place - 500 YR					
10.	01	Lands and Damages					
10.	01. 1	Non-Federal		134,500	0	0	134,500
10.	01. 2	Federal		29,000	0	0	29,000
		TOTAL Lands and Damages		163,500	0	0	163,500
10.	11	Levees and Floodwalls					
10.	11.01	Clearing/Grubbing	70000.00 SY	73,492	11,024	9,304	93,819
10.	11.02	Stripping	70000.00 SY	28,840	4,326	3,652	36,817
10.	11.03	Embankment Foundation Prep	490.00 MSF	7,155	1,073	906	9,134
10.	11.04	Levee-Embk Cut/Fill/	22300.00 CY	109,703	16,455	13,890	140,049
10.	11.07	Levee Tie-Off at University Ave		6,705	1,341	886	8,932
10.	11.08	Borrow	17300.00 CY	125,047	18,757	15,833	159,637
10.	11.09	Haul Excess Material	3000.00 CY	24,366	3,655	3,085	31,106
10.	11.10	Relocate Existing Rubble	1000.00 CY	8,193	1,229	1,037	10,459
10.	11.11	Seeding of Disturbed Areas	70000.00 SY	48,771	7,316	6,175	62,261
10.	11.12	Bedding	1300.00 TN	37,940	3,794	4,595	46,328
10.	11.13	Riprap	4200.00 TN	201,411	20,141	24,393	245,945
10.	11.14	New Gatewell -Sta 11+26		67,303	13,461	8,892	89,655
10.	11.15	New Gatewell -Sta 68+20		50,477	10,095	6,669	67,242
10.	11.16	Relocation of Electrical		37,041	7,408	4,894	49,343
10.	11.20	Mitigation		85,498	13,275	11,205	112,978
10.	11.5	Relocate Mat/Shape/Place Embkmnt	81600.00 CY	693,544	104,032	87,813	885,389
10.	11.6	Removal of Overburden	30330.00 CY	140,213	22,382	18,893	190,488
		TOTAL Levees and Floodwalls		1,757,698	259,763	222,121	2,239,582
10.	13	Pump Station Mod - Indiana					
10.	13. 1	Excavation/Pipe Removal		18,632	2,795	2,359	23,785
10.	13.10	Bedding	200.00 TN	5,888	589	713	7,190
10.	13.11	Riprap	800.00 TN	38,385	3,839	4,649	46,873
10.	13.2	Pump Station Structural Mod		18,714	3,743	2,473	24,929
10.	13.3	Backfill/Compaction		9,547	1,432	1,209	12,188
10.	13.4	Backfill/Ramp above DC Pipes		6,153	923	779	7,854
10.	13.5	New Sub Pumps/Vert Pipe		9,173	1,376	1,161	11,710
10.	13.6	New Discharge Pipes		13,688	2,738	1,808	18,234
10.	13.7	Electrical Work		36,486	7,297	4,820	48,603
10.	13.8	Remove Existing Headwall		1,652	330	218	2,201
10.	13.9	Construct New Headwall		36,113	5,417	4,572	46,103
		TOTAL Pump Station Mod - Indiana		194,431	30,478	24,762	249,671

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			QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
10.	30	Planning, Engineering, Design					
10.	30. 1	PED		444,550	0	19,382	463,932
		TOTAL Planning, Engineering, Design		444,550	0	19,382	463,932
10.	31	Construction Management					
10.	31. 1	Construction Management		266,725	0	29,366	296,091
		TOTAL Construction Management		266,725	0	29,366	296,091
10.	74	Pump Station Mod - Franklin					
10.	74. 1	Excavation/Pipe Removal		18,632	2,795	2,359	23,786
10.	74.10	Bedding	200.00 TN	5,888	589	713	7,190
10.	74.11	Riprap	800.00 TN	38,385	3,839	4,649	46,873
10.	74.2	Pump Station Structural Mod		18,714	3,743	2,473	24,929
10.	74.3	Backfill/Compaction		9,547	1,432	1,209	12,188
10.	74.4	Backfill/Ramp above DC Pipes		6,153	923	779	7,854
10.	74.5	New Sub Pumps/Vert Pipe		8,125	1,218	1,029	10,373
10.	74.6	New Discharge Pipes		10,777	2,155	1,424	14,356
10.	74.7	Electrical Work		36,486	7,297	4,820	48,603
10.	74.8	Remove Existing Headwall		1,652	330	218	2,201
10.	74.9	Construct New Headwall		35,066	5,260	4,440	44,765
		TOTAL Pump Station Mod - Franklin		189,425	29,581	24,113	243,119
10.	75	Pump Station Mod - Clark					
10.	75. 1	Excavation/Pipe Removal		21,941	3,291	2,778	28,010
10.	75.10	Bedding	200.00 TN	5,888	589	713	7,190
10.	75.11	Riprap	800.00 TN	38,385	3,839	4,649	46,871
10.	75.2	Pump Station Structural Mod		18,714	3,743	2,473	24,929
10.	75.3	Backfill/Compaction		11,022	1,653	1,396	14,071
10.	75.4	Backfill/Ramp above DC Pipes		7,884	1,183	998	10,064
10.	75.5	New Sub Pumps/Vert Pipe		10,655	1,598	1,349	13,603
10.	75.6	New Discharge Pipes		23,146	4,629	3,058	30,833
10.	75.7	Electrical Work		36,486	7,297	4,820	48,603
10.	75.8	Remove Existing Headwall		1,652	330	218	2,201
10.	75.9	Construct New Headwall		39,586	5,938	5,012	50,536
		TOTAL Pump Station Mod - Clark		215,359	34,090	27,464	276,914
10.	76	Pump Station Mod -2nd Ave					
10.	76.1	Lengthen Discharge Pipes		4,890	978	646	6,514

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			QUANTITY	UOM	CONTRACT	CONTING	ESCALATN	TOTAL COST
10.	76.2	New Submersible Pumps			205,727	41,145	27,181	274,054
		TOTAL Pump Station Mod -2nd Ave			210,618	42,124	27,827	280,568
		TOTAL Central Place - 500 YR			3,442,305	396,036	375,036	4,213,377
		TOTAL Central Place - 500 YR			3,442,305	396,036	375,036	4,213,377

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		QUANTITY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
10	Central Place - 500 YR						
10. 01	Lands and Damages						
10. 01. 1	Non-Federal			134,500	0	0	134,500
10. 01. 2	Federal			29,000	0	0	29,000
	TOTAL Lands and Damages			163,500	0	0	163,500
10. 11	Levees and Floodwalls						
10. 11.01	Clearing/Grubbing	70000.00	SY	73,492	11,024	9,304	93,819
10. 11.02	Stripping	70000.00	SY	28,840	4,326	3,652	36,817
10. 11.03	Embankment Foundation Prep	490.00	MSF	7,155	1,073	906	9,134
10. 11.04	Levee-Embk Cut/Fill/						
10. 11.04. 1	Cut	22300.00	CY	109,703	16,455	13,890	140,049
	TOTAL Levee-Embk Cut/Fill/	22300.00	CY	109,703	16,455	13,890	140,049
10. 11.07	Levee Tie-Off at University Ave						
10. 11.07. 1	Mobilize/Demobilize Equipment			863	173	114	1,150
10. 11.07. 5	Stripping/Site Preparation	52.00	CY	368	74	48	490
10. 11.07.10	Inspection Trench	47.00	CY	226	45	30	301
10. 11.07.15	Impervious Embankment	85.00	CY	736	147	97	980
10. 11.07.20	Drainage Improvements			4,142	828	547	5,517
10. 11.07.25	Seeding	623.00	SY	370	74	49	493
	TOTAL Levee Tie-Off at University Ave			6,705	1,341	886	8,932
10. 11.08	Borrow						
10. 11.08. 5	Load Borrow			37,371	5,606	4,732	47,708
10. 11.08.10	Haul Material			87,676	13,151	11,101	111,929
	TOTAL Borrow	17300.00	CY	125,047	18,757	15,833	159,637
10. 11.09	Haul Excess Material						
10. 11.09. 5	Load Excess	3000.00	CY	7,262	1,089	919	9,270
10. 11.09.10	Haul Excess			17,104	2,566	2,166	21,836
	TOTAL Haul Excess Material	3000.00	CY	24,366	3,655	3,085	31,106

			QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
10.	11.10	Relocate Existing Rubble	1000.00 CY	8,193	1,229	1,037	10,459
10.	11.11	Seeding of Disturbed Areas					
10.	11.11. 1	Seeding of Disturbed Areas		48,771	7,316	6,175	62,261
		TOTAL Seeding of Disturbed Areas	70000.00 SY	48,771	7,316	6,175	62,261
10.	11.12	Bedding					
10.	11.12. 5	Bedding, 1300 Ton	1300.00 TN	28,621	2,862	3,466	34,950
10.	11.12.10	Haul Bedding From Rail Yard	1300.00 TN	9,318	932	1,129	11,379
		TOTAL Bedding	1300.00 TN	37,940	3,794	4,595	46,328
10.	11.13	Riprap					
10.	11.13. 5	Riprap, First 4200 Ton	4200.00 TN	171,306	17,131	20,747	209,183
10.	11.13.10	Hauling Riprap From Rail Yard	4200.00 TN	30,105	3,011	3,646	36,762
		TOTAL Riprap	4200.00 TN	201,411	20,141	24,393	245,945
10.	11.14	New Gatewell -Sta 11+26		67,303	13,461	8,892	89,655
10.	11.15	New Gatewell -Sta 68+20		50,477	10,095	6,669	67,242
10.	11.16	Relocation of Electrical		37,041	7,408	4,894	49,343
10.	11.20	Mitigation					
10.	11.20. 5	Upland Tree Plantings		39,918	5,988	5,054	50,960
10.	11.20.10	Bottomland Tree Plantings		14,619	2,193	1,851	18,662
10.	11.20.15	Shrub Plantings		25,820	3,873	3,269	32,962
10.	11.20.25	Burn and Spray Bottomland Area		2,604	391	330	3,324
10.	11.20.30	Mob & Demob		5,538	831	701	7,069
		TOTAL Mitigation		88,498	13,275	11,205	112,978
10.	11.5	Relocate Mat/Shape/Place Embkmnt	81600.00 CY	693,544	104,032	87,813	885,389
10.	11.6	Removal of Overburden	30330.00 CY	149,213	22,382	18,893	190,488
		TOTAL Levees and Floodwalls		1,757,698	259,763	222,121	2,239,582
10.	13	Pump Station Mod - Indiana					
10.	13. 1	Excavation/Pipe Removal		18,632	2,795	2,359	23,785
		TOTAL Excavation/Pipe Removal		18,632	2,795	2,359	23,785

LABOR ID: CNTRPJ EQUIP ID: RG0599 Currency in DOLLARS CREW ID: NAT01A UPB ID: UP01BA

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		QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
10.	13.10 Bedding					
10.	13.10. 5 Bedding	200.00 TN	4,455	445	540	5,440
10.	13.10.10 Haul Bedding From Rail Yard	200.00 TN	1,434	143	174	1,751
	TOTAL Bedding	200.00 TN	5,888	589	713	7,190
10.	13.11 Riprap					
10.	13.11. 5 Riprap,	800.00 TN	32,651	3,265	3,954	39,870
10.	13.11.10 Hauling Riprap From Rail Yard	800.00 TN	5,734	573	694	7,002
	TOTAL Riprap	800.00 TN	38,385	3,839	4,649	46,873
10.	13.2 Pump Station Structural Mod		18,714	3,743	2,473	24,929
10.	13.3 Backfill/Compaction		9,547	1,432	1,209	12,188
10.	13.4 Backfill/Ramp above DC Pipes		6,153	923	779	7,854
10.	13.5 New Sub Pumps/Vert Pipe		9,173	1,376	1,161	11,710
10.	13.6 New Discharge Pipes		13,688	2,738	1,808	18,234
10.	13.7 Electrical Work		36,486	7,297	4,820	48,603
10.	13.8 Remove Existing Headwall		1,652	330	218	2,201
10.	13.9 Construct New Headwall					
10.	13.91. Headwall Structure/Wall		36,113	5,417	4,572	46,103
	TOTAL Construct New Headwall		36,113	5,417	4,572	46,103
	TOTAL Pump Station Mod - Indiana		194,431	30,478	24,762	249,671
10.	30 Planning, Engineering, Design					
10.	30. 1 PED		444,550	0	19,382	463,932
	TOTAL Planning, Engineering, Design		444,550	0	19,382	463,932
10.	31 Construction Management					
10.	31. 1 Construction Management		266,725	0	29,366	296,091
	TOTAL Construction Management		266,725	0	29,366	296,091
10.	74 Pump Station Mod - Franklin					
10.	74. 1 Excavation/Pipe Removal		18,632	2,795	2,359	23,786
	TOTAL Excavation/Pipe Removal		18,632	2,795	2,359	23,786

		QUANTITY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
10.	74.10 Bedding						
10.	74.10. 5 Bedding	200.00	TN	4,455	445	540	5,440
10.	74.10.10 Haul Bedding From Rail Yard	200.00	TN	1,434	143	174	1,751
	TOTAL Bedding	200.00	TN	5,888	589	713	7,190
10.	74.11 Riprap						
10.	74.11. 5 Riprap,	800.00	TN	32,651	3,265	3,954	39,870
10.	74.11.10 Hauling Riprap From Rail Yard	800.00	TN	5,734	573	694	7,002
	TOTAL Riprap	800.00	TN	38,385	3,839	4,649	46,873
10.	74.2 Pump Station Structural Mod			18,714	3,743	2,473	24,929
10.	74.3 Backfill/Compaction			9,547	1,432	1,209	12,188
10.	74.4 Backfill/Ramp above DC Pipes			6,153	923	779	7,854
10.	74.5 New Sub Pumps/Vert Pipe			8,125	1,219	1,029	10,373
10.	74.6 New Discharge Pipes			10,777	2,155	1,424	14,356
10.	74.7 Electrical Work			36,486	7,297	4,820	48,603
10.	74.8 Remove Existing Headwall			1,652	330	218	2,201
10.	74.9 Construct New Headwall						
10.	74.91. Headwall Structure/Wall			35,066	5,260	4,440	44,765
	TOTAL Construct New Headwall			35,066	5,260	4,440	44,765
	TOTAL Pump Station Mod - Franklin			189,425	29,581	24,113	243,119
10.	75 Pump Station Mod - Clark						
10.	75. 1 Excavation/Pipe Removal			21,941	3,291	2,778	28,010
	TOTAL Excavation/Pipe Removal			21,941	3,291	2,778	28,010
10.	75.10 Bedding						
10.	75.10. 5 Bedding	200.00	TN	4,455	445	540	5,440
10.	75.10.10 Haul Bedding From Rail Yard	200.00	TN	1,434	143	174	1,751
	TOTAL Bedding	200.00	TN	5,888	589	713	7,190
10.	75.11 Riprap						
10.	75.11. 5 Riprap,	800.00	TN	32,651	3,265	3,954	39,870

			QUANTITY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
10.	75.11.10	Hauling Riprap From Rail Yard	800.00	TN	5,734	573	694	7,002
		TOTAL Riprap	800.00	TN	38,385	3,839	4,649	46,873
10.	75.2	Pump Station Structural Mod			18,714	3,743	2,473	24,929
10.	75.3	Backfill/Compaction			11,022	1,653	1,396	14,071
10.	75.4	Backfill/Ramp above DC Pipes			7,884	1,183	998	10,064
10.	75.5	New Sub Pumps/Vert Pipe			10,655	1,598	1,349	13,603
10.	75.6	New Discharge Pipes			23,146	4,629	3,058	30,833
10.	75.7	Electrical Work			36,486	7,297	4,820	48,603
10.	75.8	Remove Existing Headwall			1,652	330	218	2,201
10.	75.9	Construct New Headwall						
10.	75.91	Headwall Structure/Wall			39,586	5,938	5,012	50,536
		TOTAL Construct New Headwall			39,586	5,938	5,012	50,536
		TOTAL Pump Station Mod - Clark			215,359	34,090	27,464	276,914
10.	76	Pump Station Mod -2nd Ave						
10.	76.1	Lengthen Discharge Pipes			4,890	978	646	6,514
10.	76.2	New Submersible Pumps			205,727	41,145	27,181	274,054
		TOTAL Pump Station Mod -2nd Ave			210,618	42,124	27,827	280,568
		TOTAL Central Place - 500 YR			3,442,305	396,036	375,036	4,213,377
		TOTAL Central Place - 500 YR			3,442,305	396,036	375,036	4,213,377

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		QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
10	Central Place - 500 YR					
10.	01 Lands and Damages					
10.	01. 1 Non-Federal		134,500	0	0	134,500
10.	01. 2 Federal		29,000	0	0	29,000
	TOTAL Lands and Damages		163,500	0	0	163,500
10.	11 Levees and Floodwalls					
10.	11.01 Clearing Grubbing	70000.00 SY	73,492	11,024	9,304	93,819
10.	11.02 Stripping	70000.00 SY	28,840	4,326	3,652	36,817
10.	11.03 Embankment Foundation Prep	490.00 MSF	7,193	1,073	908	9,174
10.	11.04 Levee-Embk Cut/Fill/					
10.	11.04. 1 Cut	22300.00 CY	109,703	16,455	13,890	140,049
	TOTAL Levee-Embk Cut/Fill/	22300.00 CY	109,703	16,455	13,890	140,049
10.	11.07 Levee Tie-Off at University Ave					
10.	11.07. 1 Mobilize/Demobilize Equipment		863	173	114	1,150
10.	11.07. 5 Stripping/Site Preparation	52.00 CY	368	74	48	490
10.	11.07.10 Inspection Trench	47.00 CY	226	45	30	301
10.	11.07.15 Impervious Embankment	85.00 CY	736	147	97	980
10.	11.07.20 Drainage Improvements					
10.	11.07.20. 5 12" Drainage Pipe	50.00 LF	851	170	112	1,134
10.	11.07.20.10 Gatewell	1.00 EA	3,290	658	435	4,383
	TOTAL Drainage Improvements		4,142	828	547	5,517
10.	11.07.25 Seeding	623.00 SY	370	74	49	493
	TOTAL Levee Tie-Off at University Ave		6,705	1,341	886	8,932
10.	11.08 Borrow					
10.	11.08. 5 Load Borrow		37,371	5,606	4,732	47,708
10.	11.08.10 Haul Material		87,676	13,151	11,101	111,929
	TOTAL Borrow	27300.00 CY	125,047	18,757	15,833	159,637

LABOR ID: CNTRPJ EQUIP ID: RG0599 Currency in DOLLARS CREW ID: NAT01A UPB ID: UP01EA

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			QUANTITY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
10.	11.09	Haul Excess Material						
10.	11.09. 5	Load Excess	3000.00	CY	7,262	1,089	919	9,270
10.	11.09.10	Haul Excess			17,104	2,566	2,166	21,836
		TOTAL Haul Excess Material	3000.00	CY	24,366	3,655	3,085	31,106
10.	11.10	Relocate Existing Rubble	1000.00	CY	8,193	1,229	1,037	10,459
10.	11.11	Seeding of Disturbed Areas						
10.	11.11. 1	Seeding of Disturbed Areas			48,771	7,316	6,175	62,261
		TOTAL Seeding of Disturbed Areas	70000.00	SY	48,771	7,316	6,175	62,261
10.	11.12	Bedding						
10.	11.12. 5	Bedding, 1300 Ton	1300.00	TN	28,621	2,862	3,466	34,950
10.	11.12.10	Haul Bedding From Rail Yard	1300.00	TN	9,318	932	1,129	11,379
		TOTAL Bedding	1300.00	TN	37,940	3,794	4,595	46,328
10.	11.13	Riprap						
10.	11.13. 5	Riprap, First 4200 Ton	4200.00	TN	171,306	17,131	20,747	209,183
10.	11.13.10	Hauling Riprap From Rail Yard	4200.00	TN	30,105	3,011	3,646	36,762
		TOTAL Riprap	4200.00	TN	201,411	20,141	24,393	245,945
10.	11.14	New Gatewell -Sta 11+26			67,303	13,461	8,892	89,655
10.	11.15	New Gatewell -Sta 68+20			50,477	10,095	6,669	67,242
10.	11.16	Relocation of Electrical			37,041	7,408	4,894	49,343
10.	11.20	Mitigation						
10.	11.20. 5	Upland Tree Plantings			39,918	5,988	5,054	50,960
10.	11.20.10	Bottomland Tree Plantings			14,619	2,193	1,851	18,662
10.	11.20.15	Shrub Plantings			25,820	3,873	3,269	32,962
10.	11.20.25	Burn and Spray Bottomland Area			2,604	391	330	3,324
10.	11.20.30	Mob & Demob			5,538	831	701	7,069
		TOTAL Mitigation			88,498	13,275	11,205	112,978
10.	11.5	Relocate Mat/Shape/Place Embkmnt	81600.00	CY	693,544	104,032	87,813	885,389
10.	11.6	Removal of Overburden	30330.00	CY	149,213	22,382	18,893	190,488
		TOTAL Levees and Floodwalls			1,757,698	259,763	222,121	2,239,582

			QUANTITY UOM	CONTRACT	CONTIGN	ESCALATN	TOTAL COST
10.	13	Pump Station Mod - Indiana					
10.	13. 1	Excavation/Pipe Removal		18,632	2,795	2,359	23,785
		TOTAL Excavation/Pipe Removal		18,632	2,795	2,359	23,785
10.	13.10	Bedding					
10.	13.10. 5	Bedding	200.00 TN	4,455	445	540	5,440
10.	13.10.10	Haul Bedding From Rail Yard	200.00 TN	1,434	143	174	1,751
		TOTAL Bedding	200.00 TN	5,888	589	713	7,190
10.	13.11	Riprap					
10.	13.11. 5	Riprap,	800.00 TN	32,651	3,265	3,954	39,870
10.	13.11.10	Hauling Riprap From Rail Yard	800.00 TN	5,734	573	694	7,002
		TOTAL Riprap	800.00 TN	38,385	3,839	4,649	46,873
10.	13.2	Pump Station Structural Mod		18,714	3,743	2,473	24,929
10.	13.3	Backfill/Compaction		9,547	1,432	1,209	12,188
10.	13.4	Backfill/Ramp above DC Pipes		6,153	923	779	7,854
10.	13.5	New Sub Pumps/Vert Pipe		9,173	1,376	1,161	11,710
10.	13.6	New Discharge Pipes		13,688	2,738	1,808	18,234
10.	13.7	Electrical Work		36,486	7,297	4,820	48,603
10.	13.8	Remove Existing Headwall		1,652	330	218	2,201
10.	13.9	Construct New Headwall					
10.	13.91.	Headwall Structure/Wall					
10.	13.91. .4	Excavation		115	17	15	147
10.	13.91. .6	Sheet Pile Cut-off		18,917	2,838	2,395	24,149
10.	13.91. .C	Footing Portion		3,140	471	398	4,009
10.	13.91. .E	Connection of Pipes		1,514	227	192	1,933
10.	13.91. .2	Concrete Wall		12,426	1,864	1,573	15,863
		TOTAL Headwall Structure/Wall		36,113	5,417	4,572	46,103
		TOTAL Construct New Headwall		36,113	5,417	4,572	46,103
		TOTAL Pump Station Mod - Indiana		194,431	30,478	24,762	249,671
10.	30	Planning, Engineering, Design					
10.	30. 1	PED		444,550	0	18,382	463,932

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			QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
		TOTAL Planning, Engineering, Design		444,550	0	19,382	463,932
10.	31	Construction Management					
10.	31. 1	Construction Management		266,725	0	29,366	296,091
		TOTAL Construction Management		266,725	0	29,366	296,091
10.	74	Pump Station Mod - Franklin					
10.	74. 1	Excavation/Pipe Removal		18,632	2,795	2,359	23,786
		TOTAL Excavation/Pipe Removal		18,632	2,795	2,359	23,786
10.	74.10	Bedding					
10.	74.10. 5	Bedding	200.00 TN	4,455	445	540	5,440
10.	74.10.10	Haul Bedding From Rail Yard	200.00 TN	1,434	143	174	1,751
		TOTAL Bedding	200.00 TN	5,888	589	713	7,190
10.	74.11	Riprap					
10.	74.11. 5	Riprap,	800.00 TN	32,651	3,265	3,954	39,870
10.	74.11.10	Hauling Riprap From Rail Yard	800.00 TN	5,734	573	694	7,002
		TOTAL Riprap	800.00 TN	38,385	3,839	4,649	46,873
10.	74.2	Pump Station Structural Mod		18,714	3,743	2,473	24,929
10.	74.3	Backfill/Compaction		9,547	1,432	1,209	12,188
10.	74.4	Backfill/Ramp above DC Pipes		6,153	923	779	7,854
10.	74.5	New Sub Pumps/Vert Pipe		8,125	1,219	1,029	10,373
10.	74.6	New Discharge Pipes		10,777	2,155	1,424	14,356
10.	74.7	Electrical Work		36,486	7,297	4,820	48,603
10.	74.8	Remove Existing Headwall		1,652	330	218	2,201
10.	74.9	Construct New Headwall					
10.	74.91.	Headwall Structure/Wall					
10.	74.91. .4	Excavation		112	17	14	143
10.	74.91. .6	Sheet Pile Cut-off		18,412	2,762	2,331	23,505
10.	74.91. .C	Footing Portion		3,036	455	384	3,876
10.	74.91. .E	Connection of Pipes		1,514	227	192	1,933
10.	74.91. .2	Concrete Wall		11,991	1,799	1,518	15,308

			QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
		TOTAL Headwall Structure/Wall		35,066	5,260	4,440	44,765
		TOTAL Construct New Headwall		35,066	5,260	4,440	44,765
		TOTAL Pump Station Mod - Franklin		189,425	29,581	24,113	243,119
10.	75	Pump Station Mod - Clark					
10.	75. 1	Excavation/Pipe Removal		21,941	3,291	2,778	28,010
		TOTAL Excavation/Pipe Removal		21,941	3,291	2,778	28,010
10.	75.10	Bedding					
10.	75.10. 5	Bedding	200.00 TN	4,455	445	540	5,440
10.	75.10.10	Haul Bedding From Rail Yard	200.00 TN	1,434	143	174	1,751
		TOTAL Bedding	200.00 TN	5,888	589	713	7,190
10.	75.11	Riprap					
10.	75.11. 5	Riprap,	800.00 TN	32,651	3,265	3,954	39,870
10.	75.11.10	Hauling Riprap From Rail Yard	800.00 TN	5,734	573	694	7,002
		TOTAL Riprap	800.00 TN	38,385	3,839	4,649	46,873
10.	75.2	Pump Station Structural Mod		18,714	3,743	2,473	24,929
10.	75.3	Backfill/Compaction		11,022	1,653	1,396	14,071
10.	75.4	Backfill/Ramp above DC Pipes		7,881	1,183	998	10,064
10.	75.5	New Sub Pumps/Vert Pipe		10,655	1,598	1,349	13,603
10.	75.6	New Discharge Pipes		23,146	4,629	3,058	30,833
10.	75.7	Electrical Work		36,486	7,297	4,820	48,603
10.	75.8	Remove Existing Headwall		1,652	330	218	2,201
10.	75.9	Construct New Headwall					
10.	75.91.	Headwall Structure/Wall					
10.	75.91. .4	Excavation		127	19	16	162
10.	75.91. .6	Sheet Pile Cut-off		20,808	3,121	2,635	26,564
10.	75.91. .C	Footing Portion		3,478	522	440	4,440
10.	75.91. .E	Connection of Pipes		1,514	227	192	1,933
10.	75.91. .2	Concrete Wall		13,658	2,049	1,729	17,436
		TOTAL Headwall Structure/Wall		39,586	5,938	5,012	50,536
		TOTAL Construct New Headwall		39,586	5,938	5,012	50,536

			QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
		TOTAL Pump Station Mod - Clark		215,359	34,090	27,464	276,914
10.	76	Pump Station Mod -2nd Ave					
10.	76.1	Lengthen Discharge Pipes		4,890	978	646	6,514
10.	76.2	New Submersible Pumps		205,727	41,145	27,181	274,054
		TOTAL Pump Station Mod -2nd Ave		210,618	42,124	27,827	280,568
		TOTAL Central Place - 500 YR		3,442,305	396,036	375,036	4,213,377
		TOTAL Central Place - 500 YR		3,442,305	396,036	375,036	4,213,377

Table 11 MCACES Cost Estimates, Downtown Reaches, Closure Structures

Tue 11 May 2004 — Tri-Service Automated Cost Engineering System (TRACES) — TIME 17:33:51
Eff. Date 03/24/04 — PROJECT DMCRPT: Des Moines Flood Study - Des Moines and Raccoon Rivers, Rock Island District — TITLE PAGE 1

Des Moines Flood Study
Des Moines and Raccoon Rivers,
Polk County, Iowa

DACW25-XX-B-XXXX

Designed By: CEMVR-ED-DF
Estimated By: CEMVR-ED-C (C Van Larrhoven)
POC: T. Kirkeeng, 309-794-5425

Prepared By: CEMVR-ED-C

Preparation Date: 05/10/04
Effective Date of Pricing: 05/10/04

Sales Tax: 7.0%

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LABOR ID: CNTRPJ EQUIP ID: RG0599 — Currency in DOLLARS — CREW ID: NAT01A UPB ID: UP01EA

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Tue 11 May 2004 — Tri-Service Automated Cost Engineering System (TRACES) — TIME 17:33:51
Eff. Date 03/24/04 — PROJECT DMCRPT: Des Moines Flood Study - Des Moines and Raccoon Rivers, Rock Island District — SUMMARY PAGE 1
** PROJECT OWNER SUMMARY - Contract **

	QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01 Lands and Damages		26,100	0	0	26,100
11 Levees and Floodwalls (closures)		493,076	144,519	70,199	707,794
60 PED		191,280	0	8,722	200,002
61 Construction Management		76,550	0	8,428	84,978
TOTAL Des Moines Flood Study		787,006	144,519	87,350	1,018,875

LABOR ID: CNTRPJ EQUIP ID: RG0599 — Currency in DOLLARS — CREW ID: NAT01A UPB ID: UP01EA

Tue 11 May 2004 — Tri-Service Automated Cost Engineering System (TRACES) — TIME 17:33:51
Eff. Date 03/24/04 — PROJECT DMCRPT: Des Moines Flood Study - Des Moines and Raccoon Rivers, Rock Island District — SUMMARY PAGE 2
** PROJECT OWNER SUMMARY - Bid Item **

	QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01 Lands and Damages					
01. 5 Non-Fed		11,100	0	0	11,100
01. 10 Federal		15,000	0	0	15,000
TOTAL Lands and Damages		26,100	0	0	26,100
11 Levees and Floodwalls (closures)					
11. 2 Downtown East		343,906	101,970	49,091	494,966
11. 4 Downtown South		10,376	5,188	1,714	17,277
11. 6 Downtown West		138,795	37,361	19,395	195,551
TOTAL Levees and Floodwalls (closures)		493,076	144,519	70,199	707,794
60 PED					
60. 5 PED		191,280	0	8,722	200,002
TOTAL PED		191,280	0	8,722	200,002
61 Construction Management					
61. 5 Construction Management		76,550	0	8,428	84,978
TOTAL Construction Management		76,550	0	8,428	84,978
TOTAL Des Moines Flood Study		787,006	144,519	87,350	1,018,875

LABOR ID: CNTRPJ EQUIP ID: RG0599 — Currency in DOLLARS — CREW ID: NAT01A UPB ID: UP01EA

		QUANTITY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
01	Lands and Damages						
01.	5 Non-Fed						
01.	5.5 Non-Fed			11,100	0	0	11,100
	TOTAL Non-Fed			11,100	0	0	11,100
01.	10 Federal						
01.	10.5 Federal			15,000	0	0	15,000
	TOTAL Federal			15,000	0	0	15,000
	TOTAL Lands and Damages			26,100	0	0	26,100
11	Levees and Floodwalls (closures)						
11.	2 Downtown East						
11.	2.01 Tie to I-235			112,171	28,043	15,437	155,651
11.	2.03 Amphitheater Mods			44,667	22,333	7,377	74,377
11.	2.05 RR 1st South Court Ave			3,504	1,752	579	5,835
11.	2.07 RR 2nd South Court Ave			7,757	3,878	1,281	12,916
11.	2.09 Grand Ave East			26,376	6,594	3,630	36,600
11.	2.11 Locust St East			17,681	4,420	2,433	24,534
11.	2.13 Walnut Street South			35,000	8,750	4,817	48,566
11.	2.15 Court Ave North			21,490	5,373	2,958	29,821
11.	2.17 Court Ave South			21,490	5,373	2,958	29,821
11.	2.19 Downtown East RR Closure			5,879	2,940	971	9,790
11.	2.21 RR Closure DM #41			2,167	1,083	358	3,608
11.	2.23 DM Closure 51 Vandalia Rd			45,724	11,431	6,293	63,448
	TOTAL Downtown East			343,906	101,970	49,091	494,966
11.	4 Downtown South						
11.	4.5 DM #42			4,626	2,313	764	7,702
11.	4.10 DM #36			5,750	2,875	950	9,575
	TOTAL Downtown South			10,376	5,188	1,714	17,277
11.	6 Downtown West						
11.	6.01 2nd RR South of Court			3,125	1,562	516	5,203
11.	6.03 1st RR South of Court			7,526	3,763	1,243	12,531

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			QUANTITY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST
11.	6.05	Grand Avenue		46,756	11,689	6,435	64,880
11.	6.07	Walnut Street		22,215	5,554	3,057	30,826
11.	6.09	East Locust Street		20,879	5,220	2,873	28,972
11.	6.11	Court Avenue		38,294	9,573	5,270	53,138
	TOTAL	Downtown West		138,795	37,361	19,395	195,551
	TOTAL	Levees and Floodwalls (closures)		493,076	144,519	70,199	707,794
60	PED						
60.	5	PED					
60.	5. 5	PED		191,280	0	8,722	200,002
	TOTAL	PED		191,280	0	8,722	200,002
	TOTAL	PED		191,280	0	8,722	200,002
61	Construction Management						
61.	5	Construction Management					
61.	5. 5	Construction Management		76,550	0	8,428	84,978
	TOTAL	Construction Management		76,550	0	8,428	84,978
	TOTAL	Construction Management		76,550	0	8,428	84,978
	TOTAL	Des Moines Flood Study		787,006	144,519	87,350	1,018,875

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Table 12 Cost Estimate Summary with Escalation for Birdland Park Levee

Birdland Park Levee Alignment 2, 500-Year, Des Moines and Raccoon River Flood Reduction Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.	Escalation Amount	Fully Funded Amount
1	LANDS AND DAMAGES									
	Non-Federal	1	LS	$45,000.00	$45,000.00	0%	$0.00	$45,000.00	$0.00	$45,000.00
	Federal	1	LS	$610,000.00	$610,000.00	0%	$0.00	$610,000.00	$0.00	$610,000.00
	SUBTOTAL LANDS AND DAMAGES							$655,000.00		$655,000.00
2	RELOCATIONS									
	Remove Waterline Guthrie Ave S	1000	LF	$26.00	$26,000.00	15%	$3,900.00	$29,900.00	$3,291.99	$33,192.00
	Restore sidewalk & driveways Guthrie	3500	SF	$6.50	$22,750.00	10%	$2,275.00	$25,025.00	$2,755.25	$27,780.00
	Replace Waterline Guthrie Ave N	1000	LF	$52.00	$52,000.00	20%	$10,400.00	$62,400.00	$6,870.24	$69,270.00
	SUBTOTAL RELOCATIONS							$117,325.00		$130,242.00
11	LEVEES AND FLOODWALLS									
	Silt Fence	1,600.00	LF	$2.65	$4,240.00	15%	$636.00	$4,876.00	$536.85	$5,413.00
	Clearing and Grubbing	8.65	AC	$5,550.00	$48,007.50	15%	$7,201.13	$55,208.63	$6,078.47	$61,287.00
	Strip, Stockpile/Replace Topsoil	11,000	CY	$8.75	$96,250.00	15%	$14,437.50	$110,687.50	$12,186.69	$122,874.00
	Seeding	14	AC	$2,870.00	$40,180.00	15%	$6,027.00	$46,207.00	$5,087.39	$51,294.00
	Borrow, Haul Material	132740	CY	$7.45	$988,913.00	15%	$148,336.95	$1,137,249.95	$125,211.	$1,262,461.00
	Place, Shape Embankment	145150	CY	$4.60	$667,690.00	15%	$100,153.50	$767,843.50	$84,539.57	$852,383.00
	Excavation/Disposal	25300	CY	$3.65	$92,345.00	15%	$13,851.75	$106,196.75	$11,692.26	$117,889.00
	Bedding	2,062	TON	$29.00	$59,798.00	10%	$5,979.80	$65,777.80	$7,242.14	$73,020.00
	Riprap	5,728	TON	$47.75	$273,512.00	15%	$41,026.80	$314,538.80	$34,630.72	$349,170.00
	6th Ave Ramp Asphalt Pvmnt	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45	$1,788.18	$18,030.00
	6th Ave Ramp Prime Coat	267	GA	$4.90	$1,308.30	15%	$196.25	$1,504.55	$165.65	$1,670.00
	6th Ave Ramp Aggregate Base Course	677	TON	$28.65	$19,396.05	15%	$2,909.41	$22,305.46	$2,455.83	$24,761.00
	Signage and Striping	1	LS	$1,958.00	$1,958.00	15%	$293.70	$2,251.70	$247.91	$2,500.00
	Remove & Replace 8' Chain Link Fence	100	LF	$24.85	$2,485.00	15%	$372.75	$2,857.75	$314.64	$3,172.00
	Saylor Road Closure,Structure	1	LS	$114,711.00	$114,711.00	15%	$17,206.65	$131,917.65	$14,524.13	$146,442.00
	Bike Path Asphalt Pavement	290	TON	$48.70	$14,123.00	15%	$2,118.45	$16,241.45	$1,788.18	$18,030.00
	Bike Path Prime Coat	356	GA	$4.90	$1,744.40	15%	$261.66	$2,006.06	$220.87	$2,227.00
	Bike Path Aggregate Base Course	533	TON	$31.80	$16,949.40	15%	$2,542.41	$19,491.81	$2,146.05	$21,638.00
	Drainage Structure- Sta 201+00	1	LS	$32,878.00	$32,878.00	10%	$3,287.80	$36,165.80	$3,981.85	$40,148.00
	Drainage Structure Dewatering	1	LS	$39,156.00	$39,156.00	20%	$7,831.20	$46,987.20	$5,173.29	$52,160.00
	Demolish Gatewells A&B	1	LS	$13,052.00	$13,052.00	15%	$1,957.80	$15,009.80	$1,652.58	$16,662.00

Birdland Park Levee Alignment 2, 500-Year, Des Moines and Raccoon River Flood Reduction Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.	Escalation Amount	Fully Funded Amount
	Reconstruct Gatewells A&B	1	LS	$35,240.00	$35,240.00	15%	$5,286.00	$40,526.00	$4,461.91	$44,988.00
	Seepage Berm	29400	CY	$5.35	$157,290.00	15%	$23,593.50	$180,883.50	$19,915.27	$200,799.00
	Mitigation	1	LS	$120,875.00	$120,875.00	15%	$18,131.25	$139,006.25	$15,304.59	$154,311.00
	Retaining Wall	1	LS	$70,265.00	$70,265.00	15%	$10,539.75	$80,804.75	$8,896.60	$89,701.00
	Parking Lot Repairs	1	LS	$7,610.00	$7,610.00	15%	$1,141.50	$8,751.50	$963.54	$9,715.00
	SUBTOTAL LEVEE AND FLOODWALLS							$3,371,538.60		$3,742,745.00
	TOTAL ESTIMATED CONSTRUCTION COST							$3,488,864.		$3,872,987.
30	PLANNING, ENGINEERING, AND DESIGN @ 15%							$523,640.00	$22,830.70	$546,471.00
31	CONSTRUCTION MANAGEMENT @ 9%							$314,185.00	$34,591.77	$348,777.00
	TOTAL PROJECT COST							**$4,981,689.**		**$5,423,235.**

NOTE: Basis for estimate from MCACES file for Birdland. Construction costs included overhead and profit. Price Level May 2004

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Table 13 Cost Estimate Summary with Escalation Birdland Recreation

Birdland Park Recreation, Des Moines and Raccoon River Flood Reduction Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.	Escalation Amount	Fully Funded Amount
14	RECREATIONAL FACILITIES									
	Seeding	0.5	AC	$2,620.00	$1,310.00	15%	$196.50	$1,506.50	$165.87	$1,672.00
	Borrow, Haul Material	7700	CY	$7.45	$57,365.00	15%	$8,604.75	$65,969.75	$7,263.27	$73,233.00
	Place, Shape Embankment	7700	CY	$4.80	$36,960.00	15%	$5,544.00	$42,504.00	$4,679.69	$47,184.00
	Bike Path Asphalt Pavement	560	TON	$48.75	$27,300.00	15%	$4,095.00	$31,395.00	$3,456.59	$34,852.00
	Bike Path Prime Coat	356	GA	$5.80	$2,064.80	15%	$309.72	$2,374.52	$261.43	$2,636.00
	Bike Path Aggregate Base Course	930	TON	$28.75	$26,737.50	15%	$4,010.63	$30,748.13	$3,385.37	$34,133.00
	Shoulders	490	CY	$36.85	$18,056.50	15%	$2,708.48	$20,764.98	$2,286.22	$23,051.00
	SUBTOTAL RECREATIONAL FACILITIES				$169,793.80			$195,262.87		$216,761.00
	TOTAL ESTIMATED CONSTRUCTION COST							$195,262.		$216,761.
30	PLANNING, ENGINEERING, AND DESIGN @ 15%							$29,200.00	$1,273.12	$30,473.00
31	CONSTRUCTION MANAGEMENT @ 9%							$17,520.00	$1,928.95	$19,449.00
	TOTAL PROJECT COST							**$241,982.**		**$266,683.**

NOTE: Basis for estimate from MCACES file for Birdland Recreation. Construction costs included overhead and profit. Price Level May 2004

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Table 14 Cost Estimate Summary with Escalation for Central Place Levee

Central Place, 500-Year Height, Des Moines and Raccoon River Flood Reduction Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.	Escalation Amount	Fully Funded Amount
1	LANDS AND DAMAGES									
	Non-Federal	1	LS	$134,500.00	$134,500.00	0%	$0.00	$134,500.00	$0.00	$134,500.00
	Federal	1	LS	$29,000.00	$29,000.00	0%	$0.00	$29,000.00	$0.00	$29,000.00
	SUBTOTAL LANDS AND DAMAGES							$163,500.00		$163,500.00
11	LEVEES AND FLOODWALLS									
	Clearing and Grubbing	70,000	SY	$1.05	$73,500.00	15%	$11,025.00	$84,525.00	$9,306.20	$93,831.00
	Stripping	70,000	SY	$0.40	$28,000.00	15%	$4,200.00	$32,200.00	$3,545.22	$35,745.00
	Embankment Foundation Preparation	490	MSF	$14.60	$7,154.00	15%	$1,073.10	$8,227.00	$905.79	$9,133.00
	Levee Embankment Cut/Fill	22,300	CY	$4.90	$109,270.00	15%	$16,390.50	$125,661.00	$13,835.28	$139,496.00
	Relocate/Shape/Place Embankment	81,600	CY	$8.50	$693,600.00	15%	$104,040.00	$797,640.00	$87,820.16	$885,460.00
	Removal of Overburden	30,330	CY	$4.90	$148,617.00	15%	$22,292.55	$170,910.00	$18,817.19	$189,727.00
	Levee Tie-off at University Avenue	1	JOB	SUM	$6,705.00	20%	$1,341.00	$8,046.00	$885.86	$8,932.00
	Borrow	17,300	CY	$7.25	$125,425.00	15%	$18,813.75	$144,239.00	$15,880.71	$160,120.00
	Haul Excess Material	3,000	CY	$8.15	$24,450.00	15%	$3,667.50	$28,118.00	$3,095.79	$31,214.00
	Relocate Existing Concrete Rubble	1,000	CY	$8.20	$8,200.00	15%	$1,230.00	$9,430.00	$1,038.24	$10,468.00
	Seeding of Disturbed Areas	70,000	SY	$0.70	$49,000.00	15%	$7,350.00	$56,350.00	$6,204.14	$62,554.00
	Bedding	1,300	TON	$29.25	$38,025.00	10%	$3,802.50	$41,828.00	$4,605.26	$46,433.00
	Riprap	4,200	TON	$48.00	$201,600.00	10%	$20,160.00	$221,760.00	$24,415.78	$246,176.00
	New Gatewell - Sta 11+26	1	JOB	SUM	$67,303.00	20%	$13,460.60	$80,764.00	$8,892.12	$89,656.00
	New Gatewell - Sta 68+20	1	JOB	SUM	$50,477.00	20%	$10,095.40	$60,572.00	$6,668.98	$67,241.00
	Relocation of Electrical	1	JOB	SUM	$37,041.00	20%	$7,408.20	$44,449.00	$4,893.83	$49,343.00
	Mitigation - Tree Planting	1	JOB	SUM	$88,500.00	15%	$13,275.00	$101,775.00	$11,205.43	$112,980.00
	SUBTOTAL LEVEE AND FLOODWALLS							$2,016,494.00		$2,238,509.00
13	PUMP STATIONS									
	Pump Station Modification - Indiana									
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00	$2,359.11	$23,786.00
	Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00	$2,472.52	$24,930.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00	$1,208.79	$12,188.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00	$779.07	$7,855.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$9,173.00	15%	$1,375.95	$10,549.00	$1,161.44	$11,710.00
	New Discharge Pipes	1	JOB	SUM	$13,688.00	20%	$2,737.60	$16,426.00	$1,808.50	$18,235.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00	$4,820.51	$48,604.00

Central Place, 500-Year Height, Des Moines and Raccoon River Flood Reduction Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.	Escalation Amount	Fully Funded Amount
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00	$218.22	$2,200.00
	Construct New Headwall	1	JOB	SUM	$36,113.00	15%	$5,416.95	$41,530.00	$4,572.45	$46,102.00
	Bedding	200	TON	$29.50	$5,900.00	10%	$590.00	$6,490.00	$714.55	$7,205.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00	$4,650.62	$46,891.00
	Subtotal Pump Station Mod - Indiana							*$224,939.00*		*$249,706.00*
	Pump Station Modification - Franklin									
	Excavation/Pipe Removal	1	JOB	SUM	$18,632.00	15%	$2,794.80	$21,427.00	$2,359.11	$23,786.00
	Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00	$2,472.52	$24,930.00
	Backfill/Compaction	1	JOB	SUM	$9,547.00	15%	$1,432.05	$10,979.00	$1,208.79	$12,188.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$6,153.00	15%	$922.95	$7,076.00	$779.07	$7,855.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$8,125.00	15%	$1,218.75	$9,344.00	$1,028.77	$10,373.00
	New Discharge Pipes	1	JOB	SUM	$10,777.00	20%	$2,155.40	$12,932.00	$1,423.81	$14,356.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00	$4,820.51	$48,604.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00	$218.22	$2,200.00
	Construct New Headwall	1	JOB	SUM	$35,066.00	15%	$5,259.90	$40,326.00	$4,439.89	$44,766.00
	Bedding	200	TON	$29.50	$5,900.00	10%	$590.00	$6,490.00	$714.55	$7,205.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00	$4,650.62	$46,891.00
	Subtotal Pump Station Mod - Franklin							*$219,036.00*		*$243,154.00*
	Pump Station Modification - Clark									
	Excavation/Pipe Removal	1	JOB	SUM	$21,941.00	15%	$3,291.15	$25,232.00	$2,778.04	$28,010.00
	Structural Modification	1	JOB	SUM	$18,714.00	20%	$3,742.80	$22,457.00	$2,472.52	$24,930.00
	Backfill/Compaction	1	JOB	SUM	$11,022.00	15%	$1,653.30	$12,675.00	$1,395.52	$14,071.00
	Backfill/Ramp Above Discharge Pipes	1	JOB	SUM	$7,884.00	15%	$1,182.60	$9,067.00	$998.28	$10,065.00
	New Submersible Pumps/Vertical Pipes	1	JOB	SUM	$10,655.00	15%	$1,598.25	$12,253.00	$1,349.06	$13,602.00
	New Discharge Pipes	1	JOB	SUM	$23,146.00	20%	$4,629.20	$27,775.00	$3,058.03	$30,833.00
	Electrical Work	1	JOB	SUM	$36,486.00	20%	$7,297.20	$43,783.00	$4,820.51	$48,604.00
	Remove Existing Headwall	1	JOB	SUM	$1,652.00	20%	$330.40	$1,982.00	$218.22	$2,200.00
	Construct New Headwall	1	JOB	SUM	$39,586.00	15%	$5,937.90	$45,524.00	$5,012.19	$50,536.00
	Bedding	200	TON	$29.50	$5,900.00	10%	$590.00	$6,490.00	$714.55	$7,205.00
	Riprap	800	TON	$48.00	$38,400.00	10%	$3,840.00	$42,240.00	$4,650.62	$46,891.00
	Subtotal Pump Station Mod - Clark							*$249,478.00*		*$276,947.00*
	Pump Station Modification - 2nd Avenue									
	Lengthen Discharge Pipes	1	JOB	SUM	$4,890.00	20%	$978.00	$5,868.00	$646.07	$6,514.00

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Central Place, 500-Year Height, Des Moines and Raccoon River Flood Reduction Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.	Escalation Amount	Fully Funded Amount
	New Submersible Pumps	3	EA	$68,575.00	$205,725.00	20%	$41,145.00	$246,870.00	$27,180.39	$274,050.00
	Subtotal Pump Station - 2nd Avenue							*$252,738.00*		*$280,564.00*
	SUBTOTAL PUMP STATIONS							$946,191.00		$1,050,371.00
	TOTAL ESTIMATED CONSTRUCTION COST							$2,962,685.		$3,288,880.
30	PLANNING, ENGINEERING, AND DESIGN @ 15%							$444,550.00	$19,382.38	$463,932.38
31	CONSTRUCTION MANAGEMENT @ 9%							$266,725.00	$29,366.42	$296,091.42
	TOTAL PROJECT COST							**$3,837,460.**		**$4,212,404.**

NOTE: Basis for estimate from MCACES file for Central Place. Construction costs included overhead and profit. Price Level May 2004

Table 15 Cost Estimate Summary with Escalation Downtown Reaches

Downtown Reaches, Des Moines and Raccoon River Flood Reduction Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.	Escalation Amount	Fully Funded Amount
	DOWNTOWN EAST									
1	LANDS AND DAMAGES[1]									
	Downtown East									
	Non-Federal	1	LS	$3,700.00	$3,700.00	0%	$0.00	$3,700.00	$0.00	$3,700.00
	Federal	1	LS	$5,000.00	$5,000.00	0%	$0.00	$5,000.00	$0.00	$5,000.00
	SUBTOTAL LANDS AND DAMAGES							$8,700.00		$8,700.00
11	LEVEES AND FLOODWALLS									
	Tie to I-235	1	LS	$112,175.00	$112,175.00	25%	$28,043.75	$140,219.00	$15,438.11	$155,657.00
	Amphitheater Mods	1	LS	$44,670.00	$44,670.00	50%	$22,335.00	$67,005.00	$7,377.25	$74,382.00
	RR 1st South Court Ave	1	LS	$3,500.00	$3,500.00	50%	$1,750.00	$5,250.00	$578.03	$5,828.00
	RR 2nd South Court	1	LS	$7,760.00	$7,760.00	50%	$3,880.00	$11,640.00	$1,281.56	$12,922.00
	Grand Ave East	1	LS	$26,380.00	$26,380.00	25%	$6,595.00	$32,975.00	$3,630.55	$36,606.00
	Locust Street East	1	LS	$17,690.00	$17,690.00	25%	$4,422.50	$22,113.00	$2,434.64	$24,548.00
	Walnut Street South	1	LS	$35,000.00	$35,000.00	25%	$8,750.00	$43,750.00	$4,816.88	$48,567.00
	Court Ave North	1	LS	$21,490.00	$21,490.00	25%	$5,372.50	$26,863.00	$2,957.62	$29,821.00
	Court Ave South	1	LS	$21,490.00	$21,490.00	25%	$5,372.50	$26,863.00	$2,957.62	$29,821.00
	Downtown East RR Closure	1	LS	$5,880.00	$5,880.00	50%	$2,940.00	$8,820.00	$971.08	$9,791.00
	RR Closure DM #41	1	LS	$2,170.00	$2,170.00	50%	$1,085.00	$3,255.00	$358.38	$3,613.00
	DM Closure 51 Vandalia Rd	1	LS	$45,725.00	$45,725.00	25%	$11,431.25	$57,156.00	$6,292.88	$63,449.00
	SUBTOTAL LEVEE AND FLOODWALLS			$343,930.00			$101,977.50	$445,909.00		$495,005.00
	TOTAL ESTIMATED CONSTRUCTION COST							$445,909.		$495,005.
30	PLANNING, ENGINEERING, AND DESIGN @ 30%							$133,772.70	$5,832.49	$139,605.00
31	CONSTRUCTION MANAGEMENT @ 12%							$53,509.08	$5,891.35	$59,400.00
	TOTAL PROJECT COST DOWNTOWN EAST							**$641,890.**		**$702,710.**
	DOWNTOWN SOUTH									

Downtown Reaches, Des Moines and Raccoon River Flood Reduction Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.	Escalation Amount	Fully Funded Amount
1	LANDS AND DAMAGES[1]									
	Downtown East									
	Non-Federal	1	LS	$3,700.00	$3,700.00	0%	$0.00	$3,700.00	$0.00	$3,700.00
	Federal	1	LS	$5,000.00	$5,000.00	0%	$0.00	$5,000.00	$0.00	$5,000.00
	SUBTOTAL LANDS AND DAMAGES							$8,700.00		$8,700.00
11	LEVEES AND FLOODWALLS									
	DM #42	1	LS	$4,630.00	$4,630.00	50%	$2,315.00	$6,945.00	$764.64	$7,710.00
	DM #36	1	LS	$5,750.00	$5,750.00	50%	$2,875.00	$8,625.00	$949.61	$9,575.00
	SUBTOTAL LEVEE AND FLOODWALLS							$15,570.00		$17,285.00
	TOTAL ESTIMATED CONSTRUCTION COST							$15,570.		$17,285.
30	PLANNING, ENGINEERING, AND DESIGN @ 30%							$4,671.00	$203.66	$4,875.00
31	CONSTRUCTION MANAGEMENT @ 12%							$1,868.40	$205.71	$2,074.00
	TOTAL PROJECT DOWNTOWN SOUTH							**$30,809.**		**$32,934.**
	DOWNTOWN WEST									
1	LANDS AND DAMAGES[1]									
	Downtown East									
	Non-Federal	1	LS	$3,700.00	$3,700.00	0%	$0.00	$3,700.00	$0.00	$3,700.00
	Federal	1	LS	$5,000.00	$5,000.00	0%	$0.00	$5,000.00	$0.00	$5,000.00
	SUBTOTAL LANDS AND DAMAGES							$8,700.00		$8,700.00
11	LEVEES AND FLOODWALLS									
	2nd RR South of Court	1	LS	$3,125.00	$3,125.00	50%	$1,562.50	$4,688.00	$516.15	$5,204.00
	1st RR South of Court	1	LS	$7,530.00	$7,530.00	50%	$3,765.00	$11,295.00	$1,243.58	$12,539.00
	Grand Avenue	1	LS	$46,760.00	$46,760.00	25%	$11,690.00	$58,450.00	$6,435.35	$64,885.00
	Walnut Street	1	LS	$22,215.00	$22,215.00	25%	$5,553.75	$27,769.00	$3,057.37	$30,826.00
	East Locust Street	1	LS	$20,880.00	$20,880.00	25%	$5,220.00	$26,100.00	$2,873.61	$28,974.00
	Court Avenue	1	LS	$38,925.00	$38,925.00	25%	$9,731.25	$48,656.00	$5,357.03	$54,013.00
	SUBTOTAL LEVEE AND FLOODWALLS				$139,435.00		$37,522.50	$176,958.00	$19,483.08	$196,441.00

Downtown Reaches, Des Moines and Raccoon River Flood Reduction Feasibility Study

Accnt Code	Item Description	Qty.	Unit of Meas.	Unit Cost	Total	Cont %	Contingency Amount	Total Cost With Contg.	Escalation Amount	Fully Funded Amount
	TOTAL ESTIMATED CONSTRUCTION COST							$176,958.		$196,441.
30	PLANNING, ENGINEERING AND DESIGN @ 30%							$53,087.40	$2,314.61	$55,402.00
31	CONSTRUCTION MANAGEMENT @ 12%							$21,234.96	$2,337.97	$23,573.00
	TOTAL PROJECT COST DOWNTOWN WEST							**$259,980.**		**$284,116.**
	TOTAL PROJECT COST DOWNTOWN EAST, SOUTH, AND WEST									**$1,019,760.**

NOTE: Basis for estimate from MCACES file for Downtown Reach. Construction costs included overhead and profit. Price Level May 2004.
[1] The Lands and Damages were estimated for the Downtown Reaches as a whole, and then divided evenly among the three reaches.

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DES MOINES/RACCOON RIVERS FEASIBILITY REPORT
DES MOINES/RACCOON RIVERS STUDY
POLK COUNTY, IOWA

APPENDIX E

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

FEASIBILITY STUDY
FOR
FLOOD DAMAGE REDUCTION

DES MOINES AND RACCOON RIVERS
DES MOINES, IOWA

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE DOCUMENTATION REPORT

September 2005

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Appendix E
Executive Summary

1. Background. This report summarizes the Phase I and Phase IIA Hazardous, Toxic, and Radioactive Waste (HTRW) Environmental Site Assessments (ESA) for the Des Moines and Raccoon Rivers Flood Damage Reduction Feasibility Study in accordance with Engineering Regulation (ER) 1165-2-132, HTRW Guidance for Civil Works Projects, and Engineering Regulations (ER) 405-1-12, Real Estate Handbook.

2. Conclusions. This assessment has revealed recognized environmental conditions in the following locations: Birdland Park, Central Place (including the mitigation site), Downtown West, and Downtown East project areas, and the stockpiled material at the Harriet Street Landfill. These conditions were confirmed via Phase IIA sampling, revealing metals and PAH concentrations in excess of the Iowa State Land Recycling Program Standards. Due to ongoing construction activities at the Downtown West Levee project area, between Center Street and Riverside Park, no Phase IIA ESA was conducted at the time of construction. Construction in this area removed the contaminated material, and replaced it with clean, manufactured sand, thereby removing the environmental concerns in this area. This assessment has revealed no evidence of recognized environmental conditions, such as hazardous substances, HTRW, or other regulated contaminants in connection with the Walnut Creek project area, the Downtown South project area, Leetown Creekway (the 7th Ward Ditch) project area, the Four Mile Creek project area, Reaches 6, 7, and 9, and the wetland mitigation site.

3. Recommendations. No further investigation, such as a Phase II ESA, is warranted at Walnut Creek, Downtown South, 7th Ward Ditch, or Four Mile Creek.

ER 1165-2-132 requires non-federal sponsors to supply contaminant-free land to the Federal government. Therefore, before the project can proceed on the Birdland Park, Central Place, Downtown East, and Downtown West levee alignments, as well as the use of the Harriet Street Landfill stockpiled material, the sponsor must receive HTRW clearance for these properties from the appropriate state agency. This clearance was obtained in February 2005.

The City of Des Moines coordinated with the State of Iowa and received a letter from the Iowa Department of Natural Resources (responsible for contaminated property remediation in the State of Iowa through the Land Recycling Program) dated February 7, 2005, stating that the contaminants, barely above background levels, pose a minimal threat to human health and environment, and therefore, no further investigation is required. Since the non-federal sponsor has complied with the requirements of ER 1165-2-132, the Corps can proceed with work in these areas, provided the appropriate construction safeguards are in place.

While the City has received clearance from the State of Iowa and work can proceed pursuant to ER 1165-2-132, there are still contaminants present on site. Appropriate safeguards must be identified during plans and specifications to ensure that workers remain safe during construction, that excavation of contaminated material does not create an RCRA hazardous waste pile, and that all material disposed of off-site is done so appropriately. Any remediation costs encountered during construction are the responsibility of the sponsor, with no credit to be applied toward the constructing, operating, maintaining, repairing, replacing, and/or rehabilitating Federal projects. In accordance with ER-1165-2-132 and ER 1105-2-100 (Appendix G, G-9) the feasibility report will include statements to this effect.

4. Limitations. No ESA can wholly eliminate uncertainty regarding the existence of recognized environmental conditions concerning a property. This assessment is intended to reduce, but not eliminate, uncertainty regarding the existence of recognized environmental conditions in connection with a property with reasonable limits of time and cost. Continuing the Environmental Due Diligence Audit process beyond these ESAs may reduce uncertainty, or reveal unidentified environmental liabilities. If any previously unaddressed recognized environmental condition should arise, this report will be revisited.

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1. General

1.1. **Authority**. The Des Moines and Raccoon Rivers Feasibility Study is being carried out under the US Army Corps of Engineers (Corps) General Investigations (GI) Program. The study was initiated pursuant to the provision of funds by Congress in the Energy & Water Development Appropriations Act of 1998, under the authority of Section 216 of the 1970 Flood Control Act. On September 13, 1999, the Corps, Rock Island District and the City of Des Moines entered into a partnership cost-sharing and work agreement to identify opportunities for flood damage reduction within the City.

1.2. **Guidance and Policy**. 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. Division Regulation (DIVR) 1165-2-132 provides divisional guidance for HTRW assessment for Civil Works projects. American Society for Testing and Materials (ASTM) Standards E1527-00 and E1528-00 provide a comprehensive guide for conducting Phase I Environmental Site Assessments (ESA). ASTM Standard E1903 provides guidance for Phase II ESAs. These references provide information on what considerations are to be factored into project planning and implementation. The policy of the Corps is to avoid construction of Civil Works projects when HTRW is located within project boundaries or may affect or be affected by such projects.

2. Introduction

2.1. **Purpose and Scope**. The specific purpose of a Hazardous, Toxic, and Radioactive Waste Documentation Report (HDR) is to adequately document an appropriate inquiry into HTRW activities on potential project lands. The scope of this report documents the HTRW investigation for the Des Moines and Raccoon Rivers flood damage reduction project. The goal of the Des Moines and Raccoon Rivers Project is to reduce flooding by either raising or extending the existing levee system, improving closures, and addressing other penetration concerns. Any project modification must result in improved flood prevention.

This HTRW inquiry is required in order to minimize and prevent Federal liability under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and to reduce any threats to project workers and avoid costly delays associated with environmental abatement activities. Appendix A contains a list of acronyms used in this report. A list of documents and records reviewed or referenced is contained in Appendix B.

Phase I Environmental Site Assessments were completed by Stanley Consultants, Inc. in 2002 and Missman Stanley and Associates in 2004 (see Appendix B). These assessments recommended further environmental assessments prior to proceeding with construction in several project areas. Contaminants of concern included metals, volatile organic compounds, semi-volatile organic compounds, polychlorinated biphenyls, pesticides, and polycyclic aromatic hydrocarbons. ER 1165-2-132 and DIVR 1165-2-9 recommend proceeding with Phase IIA assessments in accordance with ASTM E1903. The required Phase IIA assessment for this project included sampling soil and groundwater to determine the presence (not the extent) of any hazardous, toxic, or radioactive waste (HTRW) contamination. Phase IIA assessments were conducted by Missman Stanley and Associates in 2004 (sec Appendix B). The results of the Phase I and Phase IIA investigations are summarized in this report.

2.2. **Limiting Conditions and Methodologies Used**. The techniques used to assess HTRW contamination within and adjacent to the project area consisted of contracts with various Architectural and Engineering firms to conduct Phase I and Phase IIA ESAs. The scope of inquiry was limited to investigating onsite HTRW potential within the project boundaries as well as offsite HTRW potential within a reasonable distance from the project.

2.3. **Site Safety**. Phase I and Phase IIA ESA contracts required site safety plans for all site visits performed by Corps contractors. Therefore, a Corps site safety plan was not developed, as Corps contractors conducted all HTRW site visits.

3. Site Description

3.1. **Location and Legal Description.** The Des Moines and Raccoon River Feasibility Study is broken into several areas. Due to the size of the project, each area is discussed individually for ease of location and understanding.

3.1.1. **Des Moines and Raccoon River (DMRR) Reach 1 - Birdland Park Levee.** The Birdland Park Levee is located on the east bank of the Des Moines River, north of the confluence of the Raccoon River and the Des Moines River, in the north-central portion of Des Moines. It can be found in portions of Sections 35 and 27 of Township 79, North Range 23 West, Polk County IA.

3.1.2. **DMRR Reach 2 - Central Place Levee.** The Central Place Levee is located downstream of the Birdland Park Levee, on the west bank of the Des Moines River, north of the confluence of the Raccoon River and the Des Moines River. It can be found in portions of Section 4 of Township 78 North, Range 24 West, and Section 34, Township 79 North, Range 24 West, Polk County IA.

3.1.3. **DMRR Reach 3 - Downtown East Levee.** The Downtown East Levee is located on the east bank of the Des Moines River. It includes the confluence of the Des Moines River and the Raccoon River. At this confluence, the river turns to the east, making the levee on the north side of the bank. It can be found in Sections 3 and 10 of Township 78 North, Range 24 West, Polk County, IA.

3.1.4. **DMRR Reach 4 - Downtown West Levee.** The Downtown West Levee is located on the north bank of the Raccoon River and the west bank of the Des Moines River. The confluence of these to rivers is included in this levee area. It is located in portions of Sections 4, 5, 8, and 9 of Township 78 North, Range 24 West of Polk County, IA.

3.1.5. **Harriet Street Landfill Stockpile Borrow Area.** The borrow area is located on the north bank of the Des Moines River. It can be found in Section 11 of Township 78 North, Range 24 West, Polk County, IA.

3.1.6. **Wetland Mitigation Sites**. The upland forest wetland mitigation site is located within the southwest quarter of Section 11, Township 80 North, Range 22 West in Polk County, Iowa. Specifically, the subject property is located in rural Polk County approximately 4000 feet northeast of the intersection of the Skunk River and west of Highway 65.

3.2. **Site and Vicinity Characteristics** All levee areas and the borrow area are located within the city limits of the City of Des Moines. Two separate wetland mitigation sites were identified for this project, one of which falls outside of the city limits. Due to the size of the project, each area is discussed individually for ease of discussion and understanding.

3.2.1. **DMRR Reach 1 – Birdland Park Levee.** The Birdland Park Levee site area contains the current levee and some parkland that may be used as an alternate tie-off for the levee after construction. Currently, the area in the vicinity of the site encompasses residential, commercial, and industrial properties, with the residential areas focused on the north and east sides of the area. The Des Moines North High School, Eagle Iron Works, Dillar Battery, and McHenry Park are all currently located within the vicinity of this site. Currently, one Superfund site, the Dillar Battery site, is located in the vicinity of the site boundary.

3.2.2. **DMRR Reach 2 – Central Place Levee.** The construction area of the Central Place Levee site includes the existing levee, as well as the land directly adjacent to the levee used to support the larger footprint. Currently, the area in the vicinity of this site is divided between light industry and commercial property. The surrounding area is also mainly commercial, with no residential land within or surrounding the levee area. The bottomland hardwoods wetland mitigation site falls between the levee and the river at the Central Place alignment.

3.2.3. **DMMR Reach 3 – Downtown East Levee.** The construction for the Downtown East Levee consists of work on and near the existing levee, and improving closure structures. Currently, the area in the vicinity of the downtown east levee is highly variable. Heavy industry, light industry, commercial, and residential zones all exist near this study area. I-235, State Highway 65, and two major railroad lines run through this area. In addition, Cargill Inc. and Williams Pipeline are within the site boundaries.

3.2.4. **DMRR Reach 4 – Downtown West Levee.** The Downtown West study area is occupied with an existing levee. Closures will be upgraded. Currently, the area in the vicinity of the levee area contains heavy industry, light industry, and commercial areas. There are no residential areas within or surrounding this study area. The Meredith Corporation, Des Moines Technical High School, DICO, and the Tuttle Street Landfill are all located in the vicinity of the study area. In addition, the Des Moines TCE Superfund site and an adjacent Brownfield site are also located in close proximity to the levee.

3.2.5. **Harriet Street Landfill Stockpile Borrow Area.** The borrow area is located on the north bank of the Des Moines River. The landfill is a registered CERCLIS site, although it is not on the National Priority List. Borrow material has been excavated from another project, and is stockpiled at the landfill site.

3.2.6. **Euclid Wetland Mitigation Site.** The Euclid Wetland Mitigation Site and surrounding properties are characterized by agricultural cropland and wetland areas. A farmstead was noted adjacent to the northeast of the subject property. The southern, eastern, southeastern, and southwestern portions of the subject property were vegetated wetland. The northern, northwest corner, and central portions of the subject properties were utilized as agricultural cropland. Highway 65 borders the property to the south and southeast, while a creek/drainage ditch borders the property to the southwest. Wetland prairie vegetation borders the property to the west and north.

4. Phase I Environmental Site Assessments

Corps contracted Phase I Environmental Site Assessments for several locations associated with the subject project with Stanley Consultants, Inc. CCR, 225 Iowa Avenue, Muscatine, IA 52761 under DACW25-98-D-D005, Delivery Order 0018 on February 28, 2001. The work was completed by Stanley Environmental, Inc., Oakdale Research Park, Myriad Technology Plaza, 2658 Crosspark Road, Suite 100, Coralville, IA 52241-3212. While there was only one contract, five reports were issued summarizing Phase I Activities. Copies of these reports are available from CEMVR-ED-DN.

The Corps also contracted Phase I Environmental Site Assessments for two locations within the subject project with Missman Stanley and Associates, 1011 27th Avenue, PO Box 6040, Rock Island, 61202 under Contract No. DACW25-01-D-0004, Delivery Order 24 on

December 4, 2003, which was modified on January 7, 2004. Copies of these reports are available from CEMVR-ED-DN.

4.1. **Stanley Consultants, Inc. Phase I Environmental Site Assessment, Birdland Park Levee, May 2002** This area was occupied by a variety of property owners, and includes residential and light industrial facilities. Evidence of potential HTRW concerns was identified in the Birdland Park area, which resulted in the recommendation of Phase IIA sampling. Appendix C summarizes the areas of concern generated by this report.

4.2. **Stanley Consultants, Inc. Phase I Environmental Site Assessment, Central Place Levee, May 2002** Historically, activities in this area included salvage operations, manufacturing of various products, and commercial operations. The area is currently occupied by a variety of property owners for use as commercial or industrial purposes. Evidence of potential HTRW concerns was identified in the Central Place Levee area, which resulted in the recommendation of Phase IIA Sampling. Appendix D summarizes the areas of concern generated by this report.

4.3. **Stanley Consultants, Inc. Phase I Environmental Site Assessment, Downtown East, Four Mile Creek, 7th Ward Ditch May 2002** The Four Mile Creek and 7th Ward Ditch areas were primarily residential in nature, and no HTRW concerns were noted for these areas. However, the Downtown East area consisted of commercial, light industrial and heavy industrial uses. Evidence of potential concerns was identified in the Downtown East area, which resulted in the recommendation of Phase IIA sampling. Appendix E summarizes the areas of concern generated by this report.

4.4. **Stanley Consultants, Inc. Phase I Environmental Site Assessment, Downtown West Levee Reach 4, Raccoon Levee Reach 6, Reach 7, Des Moines-West Des Moines Reach 8, and Walnut Creek, May 2002** The Walnut Creek area and reaches 6, 7, and 8 did not have any evidence of HTRW concerns. However, evidence of potential HTRW concerns was identified in the Downtown West area, which resulted in the recommendation of Phase IIA sampling. Appendix F summarizes the areas of concern generated by this report.

4.5. **Stanley Consultants, Inc. Phase I Environmental Site Assessment, Downtown South Levee, May 2002** Historical uses in this area consisted of agricultural, manufacturing, fuel storage, and residential uses. This report did not identify the presence of any HTRW concerns, so no further HTRW Assessment was recommended.

4.6. **Missman Stanley and Associates Phase IIA Environmental Site Assessment, Harriet Street Landfill, September 2004** Little recorded evidence is available regarding the nature of the materials stored at the Harriet Street Landfill. However, investigations revealed that the stockpiled materials on top of the landfill site would not be regulated by CERCLIS.

4.7. **Missman Stanley and Associates Phase I Environmental Site Assessment, Wetland Mitigation Site, September 2004** Historically, this site has been utilized for agricultural cropland. No evidence was found indicating that the site had been developed or used as a waste disposal facility in the past. No recognized environmental conditions were identified during the Phase I ESA.

5. Phase IIA Environmental Site Assessments

The Corps contracted Phase IIA Environmental Site Assessments for several locations related to the subject project with Missman Stanley and Associates, 1011 27th Avenue, PO Box 6040, Rock Island, 61202 under Contract No. DACW25-01-D-0004, Delivery Order 24 on December 4, 2003, which was modified on January 7, 2004. Results were provided to CEMVR-ED-DN on 13 September 2004, in one report entitled *Preliminary Phase IIA Environmental Site Assessment, Flood Damage Reduction For the Des Moines and Raccoon Rivers Project, Des Moines, Iowa.* This section serves to summarize the results of the above-referenced report. Copies of this report are available from CEMVR-ED-DN.

The scope of work and sampling plan for this contract was coordinated, with the U.S. Army Corps of Engineers St. Louis District in accordance with ER 1165-2-132 and DIVR 1165-2-9, and prepared by the U.S. Army Corps of Engineers, Rock Island District, Environmental Engineering Section. The numbers of samples required for each site are shown in Table 1. For each site, surface, subsurface, and groundwater sampling was required for the constituents listed in Table 2. Sample locations are provided in the attached plates.

Table 1: Sample Location and Quantity

Project Location	Groundwater Sample Number	Surface Soil Sample Number	6-12 foot Soil Sample Number
Birdland Park	11	11	11
Central Place	2	2	2
Downtown West	9	9	9
Downtown East	14	14	14
Harriet Street Landfill	2*	2*	2*

*The Harriet Street Landfill area shall have two samples analyzed of the borrow material, two samples analyzed for the pre-existing soil substrate, and two groundwater samples.

Table 2: Required Analyses

Metals				
Item	**Method**	**Surface**	**6-12 foot**	**Groundwater**
aluminum	SW-6010B/SW-6020	x	x	x
antimony	SW-7041	x	x	x
arsenic	SW-7041/7060/7061/7062	x	x	x
barium	SW-6010B/SW-6020	x	x	x
beryllium	SW-7091	x	x	x
boron	SW-6010B	x	x	x
cadmium	SW-7131A	x	x	x
calcium	SW-6010B/SW-6020	x	x	x
chromium, total	SW-7191/7196	x	x	x
chromium, hexavalent	SW-7191/7196	x	x	x
cobalt	SW-6010B/SW-6020	x	x	x
copper	SW-6010B/SW-6020	x	x	x
iron	SW-6010B/SW-6020	x	x	x
lead	SW-7421	x	x	x
lithium	SW-6010B/SW-6020	x	x	x
magnesium	SW-6010B/SW-6020	x	x	x
manganese	SW-6010B/SW-6020	x	x	x
mercury	SW-7470/7471	x	x	x
molybdenum	SW-7481	x	x	x
nickel	SW-7521	x	x	x
potassium	SW-6010B/SW-6020	x	x	x
selenium	SW-7740/7741/7742	x	x	x
silicon	SM-3111	x	x	x
silver	SW-6010B/SW-6020	x	x	x
sodium	SW-6010B/SW-6020	x	x	x
strontium	SW-6010B	x	x	x
thallium	SW-7841	x	x	x
tin	SW-6010B	x	x	x
titanium	SW-6010B	x	x	x
vanadium	SW-6010B/SW-6020	x	x	x
zinc	SW-6010B/SW-6020	x	x	x

Table 2: Required Analysis (continued)

Volatile Organic Compounds Testing Requirements				
Item	**Method**	**Surface**	**6-12 foot**	**Groundwater**
Volatiles	SW-8260B	x	x	x
Semi-Volatile Organic Compounds Testing Requirements				
Item	**Method**	**Surface**	**6-12 foot**	**Groundwater**
Base/Neutrals Extractable Organics	SW-8270C	x	x	x
Acid Extractable Organics	SW-8270C	x	x	x
Pesticides/Polychlorinated biphenyls (PCB) Testing Requirements				
Item	**Method**	**Surface**	**6-12 foot**	**Groundwater**
Pesticides/PCBs	SW-8081/8082	x	x	x
Polynuclear aromatic compounds (PNA) or Polycylclic aromatic hydrocarbons (PAH)				
Item	**Method**	**Surface**	**6-12 foot**	**Groundwater**
Polynuclear Aromatics	SW-8310	x	x	x

5.1. **Birdland Park Levee.** Three alignments for the northern portion of this levee were considered in the Phase IIA Assessments. Soil testing indicated the presence of arsenic, beryllium, and benzo(a)pyrene in excess of the Iowa Land Recycling Program (LRP) Statewide Standards. Groundwater testing indicated the presence of arsenic, beryllium, thallium, barium, boron, cadmium, chromium, lead, manganese, nickel, selenium, and vanadium in excess of the Iowa LRP Statewide Standards. Please refer to Tables 3 and 4 for more details.

5.2. **Central Place Levee.** Soil testing indicated the presence of arsenic, beryllium, and benzo(a)pyrene throughout the levee alignment in excess of the Iowa LRP Statewide Standards. Groundwater was not present at the deepest sampling depths indicated by the contract. Therefore, no groundwater samples were analyzed for this alignment. Please refer to Table 3 for more details.

5.3. **Downtown East Levee.** Soil testing indicated the presence of arsenic, beryllium, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene in excess of the Iowa Statewide Standards. Groundwater was not present at the deepest sampling depths indicated by the contract. Therefore, no groundwater samples were analyzed for this alignment. Please refer to Table 3 for more details.

5.4. **Downtown West Levee.**

5.4.1. **Downtown West Levee, Central Place to Riverview Park.** While Phase IIA ESAs were conducted by Missman Stanley and Associates for the Corps, these Phase II assessments did not cover the west side of the river between Center Street and Riverside Park. At the time the Phase II ESA was awarded (December 2003), the City of Des Moines was performing significant construction activities

in this area that might result in existing material to a depth of 20 feet being removed from the site. The Phase I ESAs indicated that there were HTRW concerns in this area, and recommended additional analysis. Further HTRW assessment was recommended in this area, once the City of Des Moines completes their construction activities. Based on the material used as backfill, a Phase I ESA was recommended, with the potential for requiring additional Phase IIA assessments.

On February 24, 2005 CEMVR-ED-DN, in coordination with the City of Des Moines, determined the following: The Iowa Department of Transportation had administered a project in Des Moines, referred to as the "Birds Run Outlet Storm Sewer Project." The work occurred in 2003 and 2004 during the construction season. In order to replace the sewer line, at least 20 feet of material was excavated near the areas proposed for Corps activities. The material was primarily rubble, and was removed off-site. Clean, manufactured sand was brought on site, and used as backfill. Corps levee activities were not anticipated to perform work as deep as 20 feet. Therefore, it does not appear that there are any further HTRW concerns with this site location.

5.4.2. Downtown West Levee, Remaining Areas. Soil analysis revealed the presence of arsenic, beryllium, and benzo(a)pyrene in excess of the Iowa LRP Statewide Standard throughout the levee alignment. Groundwater analysis revealed the presence of arsenic, cadmium, barium, thallium, beryllium, chromium, lead, manganese, molybdenum, nickel, selenium, vanadium, and zinc in the single sample taken from the site. Please refer to Tables 3 and 4 for more details.

5.5. **Harriet Street Landfill and Borrow Material.** Soil analysis revealed the presence of arsenic and beryllium concentrations in excess of the Iowa Statewide LRP Statewide Standards. Please refer to Table 3 for more details.

Table 3: Soil Sampling Results

Contaminant	No. of positive samples	Conc. Range (mg/kg)	Mean Level (mg/kg)	Median Level (mg/kg)	IA State Standard (mg/kg)
Birdland Park					
Arsenic	19	1.7-8.4	4.6	4.9	1.4
Beryllium	6	0.58-2.8	1.29	0.71	0.48
Benzo(a)pyrene	2	0.39-2.1	1.25	NA	0.29
Central Place					
Arsenic	5	2.7-7.4	5.0	4.4	1.4
Beryllium	2	0.54-0.68	0.61	NA	0.48
Benzo(a)pyrene	1	0.41	0.41	NA	0.29
Downtown East					
Arsenic	29	1.7-7.9	3.9	3.4	1.4
Beryllium	16	0.50-0.95	0.63	0.58	0.48
Lead	1	440	440	NA	400
Benzo(a)anthracene	4	3.9-33	18.0	8.1	2.9
Benzo(a)pyrene	9	0.31-23	7.2	3.4	0.29
Benzo(b)flouranthene	4	3.7-26	19.4	22	2.9
Indeno(1,2,3-cd) pyrene	3	3.0-6.8	5.4	6.4	2.9
Downtown West					
Arsenic	16	1.9-9.3	3.7	3.1	1.4
Beryllium	9	0.51-4.0	1.0	0.68	0.48
Benzo(a)pyrene	1	0.67	0.29	NA	0.29
Harriett Street Landfill					
Arsenic	3	3.2-3.8	4.1	3.8	1.4
Beryllium	1	0.56	0.56	NA	0.48

Table 4: Groundwater Sample Results

Contaminant	No. of positive samples	Concentration Range (mg/L)	Iowa State Standard (mg/L)
Birdland Park			
Arsenic	2	0.13-0.19	0.05
Beryllium	2	0.014-0.016	0.004
Thallium	2	0.0046-0.0047	0.002
Barium	2	3.3-6.6	2.0
Boron	2	0.82-0.85	0.6
Cadmium	1	0.0062	0.005
Chromium	3	0.28-1.3	0.1
Lead	3	0.21-2.0	0.015
Manganese	3	6.6-38	0.98
Nickel	2	0.46-0.51	0.1
Selenium	2	0.10-0.11	0.05
Vanadium	3	0.17-0.75	0.049
Downtown West			
Arsenic	1	0.34	0.05
Cadmium	1	0.088	0.005
Thallium	1	0.017	0.002
Barium	1	46.0	2.0
Beryllium	1	0.05	0.004
Chromium	1	1.5	0.1
Lead	1	0.57	0.015
Manganese	1	380	0.98
Molybdenum	1	0.064	0.4
Nickel	1	2.8	0.1
Selenium	1	0.6	0.05
Vanadium	1	2.1	0.049
Zinc	1	3.5	2

5. Iowa Department of Natural Resources (IA DNR) Coordination

The City of Des Moines coordinated with the IA DNR on the areas of concern, including Birdland Park Levee, Central Place Levee, Downtown East Levee, Downtown West Levee, and the Harriet Street Landfill. Based on the information provided to the IA DNR, it was their view that the sites presented minimal threat to human health and the environment, and therefore, no further investigation is required. The IA DNR reserved the right to require additional investigation if future information warrants such action.

6. Findings and Conclusions

There have been numerous HTRW investigations conducted over the project areas. A listing of reports documenting these investigations and whether or not there are any HTRW concerns is shown in Table 5 below.

Table 5: Summary of Activities

Project Location	Phase I	Phase IIA	HTRW Concern
Birdland Park Southern Levee	Stanley Consultants, Inc. (Stanley)	Missman Stanley and Associates (MSA)	Yes
Birdland Park Northern Levee - Alignment 1	Stanley	MSA	Yes
Birdland Park Northern Levee - Alignment 2	Stanley	MSA	Yes
Birdland Park Northern Levee - Alignment 3	Stanley	MSA	Yes
Central Place Levee	Stanley	MSA	Yes
Downtown East Levee	Stanley	MSA	Yes
Downtown West Levee	Stanley	MSA	Yes
Downtown West Levee Central Place to Riverview Park	Stanley	None.	Yes
Downtown South Levee	Stanley	None.	No
Walnut Creek	Stanley	None.	No
7th Ward Ditch	Stanley	None.	No
Four Mile Creek	Stanley	None.	No
Harriet Street Landfill	MSA	MSA	Yes
Wetland Mitigation Site	MSA	None.	No

6.1. **Areas with No Environmental Concerns**

6.1.1. **7th Ward Ditch, Four Mile Creek, Downtown South Levee, and the Wetland Mitigation Site.** This assessment has revealed no evidence of hazardous substances, HTRW, or other regulated contaminants in connection with the following project study areas: 7th Ward Ditch, Four Mile Creek, the Downtown South Levee and the wetland mitigation site.

6.1.2. **Downtown West Levee Between Center St. and Riverview Park.** The Downtown West levee, between Center Street and Riverview Park continues to have evidence of hazardous substances. Specifically, the Phase I report for this area located several areas of HTRW concern including:

- Des Moines Tanning Company, City Fuel and Supply Company, and the Des Moines Steel Company located at Southwest 3rd St. North of Raccoon River;
- Iowa Iron and Brass Co., Hawkeye Machine and Iron Works, and Junkyard at W 2nd St. and W. Court Ave.;
- Des Moines Electric Street Railway and Power House, Proctor Coal Company, State Arsenal, J. B. Loughran-Machinery Shop and Foundry, and Creek Fill located at W. 2nd St. and Locust St.;
- Coal fired power plants located at Chestnut St. on west bank of Des Moines River;
- S. Green and Sons Foundry, Kratzer Carriage Co., Friction Proof Lubricant Co., Des Moines Fuel and Feed Co, and Ink Manufacturing Co. located at W. 1st and 2nd St. and W. Market St.

No Phase IIA HTRW investigations have occurred in this area at the time of this report due to construction activities scheduled for late 2003 that may have changed the nature of the contaminants at these locations. Construction in this area removed the contaminated material, and replaced it with clean, manufactured sand, thereby removing the environmental concerns in this area.

6.1.3. **Birdland Park Levee, Central Place Levee, Downtown East Levee, Downtown West Levee Remaining Areas, and the Harriet Street Landfill.** Phase IIA soils analysis has confirmed the presence of metals and PAHs in excess of Iowa State Land Recycling Program Standards for the following levee alignments: Birdland Park, Central Place, Downtown East, and Downtown West. In addition, the proposed fill material, located at the Harriett Street Landfill, has levels of arsenic and beryllium in excess of the Iowa State Land Recycling Program standards. Refer to Table 3 for concentration ranges. Groundwater samples at Birdland Park and Downtown West have revealed the presence of metals, as detailed in Table 4, in excess of Statewide Iowa Land Recycling Standards.

Per ER 1165-2-132, contaminated land should be avoided if at all possible. However, since the levees in question were built on contaminated property,

avoidance no longer is a feasible option for this project. Instead, CEMVR-ED-DN personnel recommend that the sponsor enter into the Iowa Land Recycling Program (LRP). The result of this program is a certificate of No Further Remedial Action Planned (NFRAP) or equivalent. It is the State's policy that a NFRAP certificate meets the requirements of remediation, therefore, a plot of land with a NFRAP certificate may be viewed the same as a parcel without any previous contamination. It should be noted that certificates could be voided by additional, post-issuance contamination.

ER 1165-2-132 states clearly that construction shall not be undertaken until the sponsor, at the sponsor's expense, completes all remedial actions. Therefore, in light of the contamination identified at the Birdland Park, Central Place, Downtown West, and Downtown East levee systems, as well as the proposed fill material located at the Harriett Street Landfill, construction shall not proceed until a NFRAP certificate or equivalent is obtained.

Prior to submission of the feasibility report, the sponsor must supply the Corps with a letter of intent, accepting responsibility for the remediation and outlining the steps that will be taken to secure a NFRAP certificate or equivalent. If this certificate is obtained prior to the submission of the feasibility report, it should be included in the HTRW Appendix. Once a project site is deemed remediated, construction may proceed.

In February 2005, the sponsor received a letter from the Iowa Department of Natural Resources which was the equivalent to the NFRAP certificate.

7. Recommendations

While legally, there are no environmental concerns associated with this project (upon receipt of a letter from the IA DNR), there are still contaminants present on site. Appropriate safeguards must be identified during plans and specifications to ensure that workers remain safe during construction, that excavation of contaminated material does not create an RCRA hazardous waste pile, and that all material disposed of off-site is done so appropriately.

8. Limitations

No ESA can wholly eliminate uncertainty regarding the existence for recognized environmental conditions concerning a property. This assessment is intended to reduce, but not eliminate, uncertainty regarding the existence of recognized environmental conditions in connection with a property with reasonable limits of time and cost. If any previously unaddressed recognized environmental condition should arise, this HDR will be revisited.

Appendix E-A
Acronyms

AIRS/AFS	Aerometric Information Retrieval System/AIRS Facility Subsystem
AST	Above ground storage tank
ASTM	American Society for Testing and Materials
BRS	Biennial Reporting System
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CEMVR	Corps of Engineers, Mississippi Valley Division, Rock Island District
DIVR	Division Regulation
DOD	Department of Defense
ED-DN	Engineering Division - Environmental Engineering Section
EM	Engineering Manual
EMCI	EnviroFacts Master Chemical Integrator
EPA	Environmental Protection Agency
ER	Engineering Regulation
ESA	Environmental Site Assessment
FII	Facility Identification Initiative
GI	General Investigation
GICS	Grants Information and Control System
GIS	Geographic Information System
HDR	HTRW Documentation Report
HTRW	Hazardous, Toxic, and Radioactive Waste
IA	Iowa
ICR	Information Collection Rule
ILEPA	Illinois Environmental Protection Agency
LUST	Leaking Underground Storage Tanks
LRP	Land Recycling Program
NFRAP	No Further Action Planned (Certificate)
NCOD	National Contaminant Occurrence Database
NPL	National Priorities List
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PNA	Polynuclear aromatic compound
PCS	Permit Compliance System
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Information System
SDWIS	Safe Drinking Water Information System
SEIDS	Site Environmental Information Data System
SSHP	Site Specific Safety and Health Plan
TRIS	Toxic Release Inventory System
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UST	Underground storage tank
VOC	Volatile organic compounds

Appendix E-B
References and Abstracts

Stanley Consultants, Inc., Phase I Environmental Site Assessment, Birdland Park Levee, May 2002.

Stanley Consultants, Inc., Phase I Environmental Site Assessment, Downtown East Levee Reach 3, Four Mile Creek, 7th Ward Ditch, May 2002.

Stanley Consultants, Inc., Phase I Environmental Site Assessment, Downtown West Levee Reach 4, Raccoon Levee Reach 6, Reach 7, Des Moines-West, Des Moines Reach 8, and Walnut Creek, May 2002.

Stanley Consultants, Inc., Phase I Environmental Site Assessment, Central Place Levee, May 2002.

Missman, Stanley and Associates, P. C. Phase I Environmental Site Assessment, City of Des Moines Wetland Mitigation Area, Polk County, Iowa. 13 September 2004.

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U.S. Army Corps of Engineers, ER 1165-2-132, Water Resources Policies and Authorities - Hazardous, Toxic and Radioactive Waste (HTRW) Guidance for Civil Works Projects, June 26, 1992. http://www.hnd.usace.army.mil/techinfo/engpubs.htm

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U.S. Army Corps of Engineers (USACE), ER 385-1-92, Safety and Occupational Health Document Requirements for Hazardous, Toxic, and Radioactive Waste (HTRW), Appendix B, March 18, 1994.http://www.hnd.usace.army.mil/techinfo/engpubs.htm

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U.S. Army Corps of Engineers (USACE), EM 200-1-3, Requirements for the Preparation of Sampling and Analysis Plans, February 1, 2001.
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U. S. Army Corps of Engineers, Policy Guidance Letter ER 1105-2-100 No. 34, CECW-PA, Non-CERCLA Regulated Contaminated Materials at Civil Works Projects, 5 May 1992.

U. S. Army Corps of Engineers, ER 405-1-12, Real Estate Handbook, Chapter 8.

U. S. Army Corps of Engineers, ER 500-1-1, Natural Disaster Procedures.

Appendix E-C
Summary of Phase 1 Environmental Assessment
Birdland Park Levee

A. R. Syens
October 9, 2001

This document serves to summarize the contents of the report "Phase 1 Environmental Site Assessment Birdland Park Levee", completed by Stanley Consultants, Inc. in July 2001. In some instances, contaminants were excluded from the report, and added them. If this occurs, it will be noted in the summary with an asterisk *.

Location of Concern: 4th St. and New York Ave. (BP1)
Timeframe: 1920s
Company: Des Moines Silo and Manufacturing Co.
Products: Lumber creosoting area, lumber warehouse, machine shop, and sheet metal shop
Possible contaminants:

- Lumber treatment chemicals
- Creosote
- Pentachlorophenol
- Degreasers and lubricants

Timeframe: 1951
Company: Hargrove Co.
Products: Farm equipment, sheet metal shops, air conditioning warehouse, paint shop
Possible contaminants:

- Lubricants and degreasers
- Paints*

Timeframe: 1951
Company: Dellman Co.
Products: Windshield washers
Possible contaminants:

- Chlorinated solvents

Timeframe: 1968
Company: Engman Manufacturing Co/ EMCO Specialties Inc.
Products: Auto salvage and parts, storm doors
Possible Contaminants:

- Paint
- Solvents
- Oil/gasoline/antifreeze *

Multiple large fuel oil tanks located at this site from 1951- 1968

Location of concern: W. 2nd Ave. and New York Ave. (BP2)
Timeframe: 1968
Company: Dry Cleaning Warehouse
Possible Contaminants:

- Chlorinated solvents

Timeframe: 1968
Company: Used Auto Sales and Repair
Possible Contaminants:

- Degreasers, lubricants
- Oil, gasoline, antifreeze *

Timeframe: 1951-1968
Company: Western Tool and Stamping
Products: tools and metal stamping, plating
Possible contaminants:

- Chromium
- Chlorinated solvents
- Oil, lubricants, and solvents

Location of Concern: W. 2nd Ave. and W. 1st St., three blocks from the river (BP3)
Timeframe: 1951-1968
Company: Filling station and bulk oil station
Possible contaminants

- 4 fuel tanks
- 1 oil warehouse
- 5 oil tanks
- 4 buried tanks, all unregulated

Location of Concern: W. 2nd Ave. and Watson Ave. (BP4)
Timeframe: 1957- present
Company: Eagle Iron Works
Products: Foundry, steel warehouse, mechanical shop, lab, storage tanks
Possible Contaminants:

- Chlorinated solvents
- Metals
- PCBs
- Hazardous waste
- AST

ERS listings:

- RCRA Large and Small quantity generators
- CORRACTS
- PADS
- FINDS
- TRIS

Location of Concern: 701 Corning Ave. (BP5)
Company: Diller Battery Site
Possible Contaminants:

- Lead*
- Chlorinated solvents
- Liquid tire wastes- general dump site pre 1950s

ERS Listings:

- CERCLIS Superfund site

Location of Concern: 501 Holcomb (BP6)
Company: Des Moines North High School
Possible Contaminants:

- LUST leakage site
- Former landfill
- Positive test for subsurface chlorinated solvents

Location of Concern: 2427 2nd Ave. (BP7)
Company: Lombard Investments:
Possible Contaminants:

- LUST site

Additional Concerns:
Multiple positive test sites in the area for the following chemicals:

- Petroleum and Petroleum constituents
- VOCs
- Metals
- Chlorinated Compounds
- Polynuclear Aromatic Hydrocarbons (PAHs)

For a map of the areas of negative impact, please refer to Figure 3, ERD Listed Site Inventory, Environmental Data Resources, 2001, in the report.

Appendix E-D
Summary of Phase 1 Environmental Assessment
Central Place

A. R. Sycns
October 11, 2001

This document serves to summarize the contents of the report "Phase 1 Environmental Site Assessment Des Moines River Northwest Levee", completed by Stanley Consultants, Inc. in July 2001. The USACE refers to this levee as the Central Place Levee. This area currently contains mostly commercial use property with some light industry. Initially, this property was used as a salvage yard. As a result, there is an increased risk of heavy metal, hydrocarbon and PCB contamination. All sites of concern have been mapped and can be found using the code assigned to each individual site.

Location of Concern: School St. and Willow St. at West 1st St. (CP1)
Timeframe: 1920-1969
Company: Locomotive warehouse, car barn, tool shed, cement shed, sand tank
Possible contaminants:

- Degreasers
- Lubricants
- Hydrocarbons

Note: This site is currently under I-235

Location of concern: W 1st St. and Willow St. (CP2)
Timeframe: 1957-1969
Company: City of Des Moines Asphalt Plant
Possible Contaminants:

- PAHs

Location of Concern: W University Ave. and W 1st St. (CP3)
Timeframe: 1951-1968
Company: University Ave. Coal Yard
Possible contaminants

- Metals (arsenic)

Location of Concern: Ascension St. and W 1st St. (CP4)
Timeframe: 1950-1957
Company: Scrap iron yard
Possible contaminants

- PCBs

Additional Concerns:
CERCLIS Sites:

- Two Rivers Glass and Door, Inc. 116 Forest Ave. (CP5)
- U. S. Postal Service 1165 2nd Ave. (CP6)

RCRIS Sites
Large Quantity- McKesson Chemical Co
16 Small Quantity generators (refer to report for list)

CORRACT Sites

- McKesson Chemical Co
- Mercy Hospital Medical Center

RAATS

- Mercy Hospital Medical Center

Twenty-one sites were listed as FINDS sites. Please refer to the report for the complete listing.

TRIS

- Iowa Paint Manufacturing Co

Twenty-four UST sites are listed in the report, as well as sixteen LUST sites.

Appendix E-E
Summary of Phase I Environmental Assessment
Downtown East

A. R. Syens
October 11, 2001

This document serves to summarize the contents of the report "Phase 1 Environmental Site Assessment Des Moines River Southeast Levee", completed by Stanley Consultants, Inc. in July 2001. This area currently contains mostly commercial use property with some light industry. All sites of concern have been mapped and can be found using the code assigned to each individual site.

Land use in the Downtown East Levee area is highly variable, containing heavy industrial, light industrial, commercial, and residential areas. It is surrounded by commercial, industrial, and rural areas. Parts of this area have been industrial prior to 1905. Salvage yards have historically been located throughout this area, but have been moved by the city.

Location of Concern: Maple St. and East 4th St. (DE1)
Timeframe: 1901-1950
Company: Chicago Northwestern Railroad
Products: Turntable, coal shed, 3 ASTs
Possible contaminants:

- Degreasers
- Lubricants
- Hydrocarbons

Location of concern: Maple St. and East 2nd St. (DE2)
Timeframe: 1920-1960
Company: City of Des Moines Department of Streets
Possible Contaminants:

- Degreasers
- Paints or coatings
- Lubricants

Location of Concern: E. 1st St. and Maple St. (DE3)
Timeframe: 1950s
Company: Des Moines Ice and Fuel Co.
Possible contaminants

- Paint and coatings
- Petroleum hydrocarbons

Location of Concern: E 1st St. and E Walnut St. (DE4)
Timeframe: 1901-1920s
Company: Des Moines Gas Engine Co
Possible contaminants

- Casting residuals
- Degreasing solvents

Location of Concern: E 2nd St. and Locust St. (DE5)
Timeframe: 1920s
Company: Waterbury Chemical Supply
Possible contaminants

- Chlorinated Solvents

Location of Concern: E 2nd St. and E Grand Ave. (DE6)
Timeframe: 1950-1969
Company: Filling station
Possible contaminants

- Petroleum products from leaking USTs

Location of Concern: E Court Ave. and E 1st St. (DE7)
Timeframe: 1891-1901
Company: Des Moines Manufacturing and Supply Co
Possible contaminants

- Solvents
- Degreasers
- Lubricants
- Die lubricants
- Foundry sands
- Combustion byproducts

Location of Concern: E Walnut St. and E 1st St. (DE8)
Timeframe: 1901-1920s
Company: American Iron Works
Possible contaminants

- Degreasers
- Die lubricants
- Foundry sands
- Combustion byproducts

Location of Concern: E 2nd St. and E Court Ave. (DE9)
Timeframe: 1920s
Company: McDonnell Boiler and Iron Works
Possible contaminants

- Foundry sands
- Die lubricants
- Combustion byproducts
- Waste metal

Location of Concern: E 3rd St. and E Court Ave. (DE10)
Timeframe: 1901-1920s
Company: Dempster Manufacturing and Supply Co
Possible contaminants

- Degreasers
- Lubricants
- Metals from foundry
- Hydrocarbons from spills

Location of Concern: E 2nd St. and E Walnut St. (DE11)
Timeframe: 1903-1920s
Company: Central Wire and Iron Works
Possible contaminants

- Lubricants
- Waste metals

Location of Concern: E 3rd St. and E Walnut St. (DE12)
Timeframe: 1950s
Company: Auto repair and painting, foundry and an electroplating shop
Possible contaminants

- Degreasers
- Lubricants
- Chlorinated solvents
- Chromium
- Paint

Location of Concern: E 2nd St. and E Court Ave. (DE13)
Timeframe: 1969
Company: Iowa Casket Co
Possible contaminants

- Paint thinners

Location of Concern: E 1st St. and E Vine St. (DE14)
Timeframe: 1891-1969
Company: Capital City Gas Light Co/Des Moines Gas-Light Co
Possible contaminants
- Hydrocarbons

Note: According to the Iowa DNR, this site is PROFOUNDLY contaminated and poses a significant potential for off-site contamination of soil and groundwater.

Location of Concern: SE 2nd St. and Market St. (DE15)
Timeframe: 1950-1969
Company: Skelly Oil Co
Possible contaminants
- Fuel and oil spills

Location of Concern: SE 1st St. and E Market St. (DE16)
Timeframe: 1900s
Company: WM Viggers Iron Works
Possible contaminants
- Foundry sands
- Die lubricants
- Machining lubricants
- Combustion byproducts
- Solvents

Location of Concern: E Elm St. and SE 1st St. (DE17)
Timeframe: 1920-1950
Company: Globe Tanning and Manufacturing Co
Possible contaminants
- Acids
- Bases

Location of Concern: E Market St. and SE 1st St. (DE18)
Timeframe: 1960s
Company: Iowa Power and Light Co
Possible contaminants
- PCBs

Location of Concern: SE 3rd St. and Allen St. (DE19)
Timeframe: 1950-1969
Company: transformer yard, iron works, electroplating co
Possible contaminants
- PCBs
- Chromium
- Chlorinated solvents

Location of Concern: 3030 E Granger Ave. (DE20)
Timeframe: 1930s-present
Company: Cargill, Inc
Possible contaminants

- Grain Fumigants like carbon tetrachloride

Additional Concerns:
RCRIS Sites
11 Small Quantity generators (refer to report for list)

TSD Site
Thompson Hayward Chemical Company

NFRAP Site
Two Rivers Service Center

RAATS
Thompson Hayward Chemical Company

Twelve sites were listed as FINDS sites. Please refer to the report for the complete listing.

TRIS

- Titan Tire Manufacturing, Inc
- Cargill, Inc
- Thompson Hayward Chemical Company

Capital City Gas and Light Co was a former producer of gas from coal. It has been profoundly impacted because of this activity.

Twenty-five UST sites are listed in the report, as well as twenty-one LUST sites.

Williams Pipeline is listed as an SWF. There have been substantial releases of petroleum hydrocarbons from this site, which probably extends under the current levee alignment.

Appendix E-F
Summary of Phase 1 Environmental Assessment
Downtown West Levee

A. R. Syens
October 10, 2001

This document serves to summarize the contents of the report "Phase 1 Environmental Site Assessment Des Moines River/Raccoon River Levee", completed by Stanley Consultants, Inc. in July 2001.

Des Moines West Levee

This area contains heavy and light industry as well as some commercial property. No residential property lies within or adjacent to the study area. This area has been industrial since the mid-1800s.

Location of Concern: Grand Ave. and W. 18th St. (DW1)
Timeframe: 1920-1969
Company: Wallace and Homestead Co.
Products: Printing
Possible contaminants:

- Lead
- Solvents
- Lubricants
- PCBs

Timeframe: 1950
Company: Solar Aircraft Co.
Products: Airplane intake Manifolds
Possible contaminants:

- Oils storage tank
- RR spur
- Chlorinated solvents
- Historical spills
- Site fill was obtained from foundry sand

NOTE: Site is currently Des Moines Technical High School

ERS Listings:

- CERCLIS
- FINDS

Location of concern: 1716 Locust St. (DW2)
Timeframe: 1902-present
Company: Successful Farming Publishing Company/Meredith Corporation
Product: Printing
Possible Contaminants:

- Lead
- Solvents
- PCBs
- Metal from coal ash

Location of concern: 15th St. and Mulberry St. (DW3)
Company: Shannon and Mott Co.
Product: Metal processing
Possible Contaminants:

- Metals
- Lubricants

Location of Concern: 200 Southwest 16th St. (DW4)
Timeframe: 1950-present
Company: Dico Corp.
Products: Metal stampings, chemicals, aircraft parts, printing
Possible contaminants:

- ~20 chemical storage tanks
- Insecticide warehouse
- Herbicide warehouse
- TCE
- Oily sludge
- Perchloroethylene
- 1,2-Dichlorocthane
- Vinyl Chloride

ERS Listings:

- NPL Site
- CERCLIS
- RCRIS Large Quantity Producer
- FINDS
- SUPERFUND ROD
- SUPERFUND CONSENT

Location of Concern: West 12th St. and Cherry St. (DW5)
Timeframe: 1920s
Company: James Horrabin and Co.
Product: Asphalt Storage
Possible contaminants

- PAHs

Location of Concern: Southwest 5th St. and Murphy St. (DW6)
Companies: International Oil Company
Des Moines Garbage Disposal Plant
Carbon Coal Company
5-7 Historic Oil Corporations and Refineries
Possible Contaminants:

- 9 storage tanks
- 40 oil storage tanks
- Oil drum storage area
- Coal yard
- 3 filling stations
- Oil and grease warehouse
- Metals

Location of Concern: Southwest 9th St. and Murphy St. (DW7)
Companies: Pure Oil Co.
Cities Service Oil Co.
New Monarch Machine and Stamping Co
Possible Contaminants:

- 35 storage tanks
- Hydrocarbons
- Metals
- Lubricants
- Solvents
- PCBs

Location of Concern: Southwest 3rd St. North of Raccoon River (DW8)
Companies: Des Moines Tanning Company
City Fuel and Supply Company
Des Moines Steel Company
Products: Burner and coal storage, tanning, fuel supply
Possible Contaminants:

- Acids
- Bases
- Combustion byproducts
- Metals

Location of Concern: Southwest 1st St. and S Union between W. Jackson Ave. and W. Granger Ave. (DW9)
Company: Thompson-Hayward Chemical Co.
Product: Chemical storage warehouse
Possible Contaminants:

- Industrial solvents

Location of Concern: W 2nd St. and W Court Ave. (DW10)
Companies: Iowa Iron and Brass Co.
Hawkeye Machine and Iron Works
Junkyard
Possible contaminants:

- Metals
- Lubricants
- Solvents

Location of Concern: W. 2nd St. and Locust St. (DW11)
Companies: Des Moines Electric Street Railway and Power House
Proctor Coal Company
State Arsenal
J. B. Loughran-Machinery Shop and Foundry
Possible contaminants:

- Creek was buried between 1891 and 1920 with unknown material
- PCBs
- Metals
- Solvents
- Hydrocarbons

Location of Concern: W 15th St. to W 17th St., Grand Ave. to Walnut St. (DW12)
Companies: Manhattan Oil Co
Standard Oil Co
Prestone-Lite Service Station
Williard Storage Battery Service Station

Possible contaminants:

- 10 USTs
- Oils
- Gasoline
- Diesel

Location of Concern: W 13th St. and Mulberry St. (DW13)
Company: Des Moines Union Railroad Shops and Yard
Products: Roundhouse, repair shops, machine shops, paint shops, major service to locomotive engines
Possible contaminants:

- Hydrocarbons
- Lubricants
- Solvents
- Insecticides
- PCBs
- Metals
- Paint

Location of Concern: Southwest 9th St. and Raccoon River (DW14)
Companies: Sater Tanning Co
Paragon Refining Co
Stoner Wall Paper Manufacturing Co
Pitt Des Moines Steel Co
FE Jackson Coal
Gibson Fuel
Possible contaminants:

- Paints
- Oils gasoline
- Diesel
- Acids
- Bases
- Kerosene
- Fuel oil
- Heavy metals

Location of Concern: Chestnut St. on west bank of Des Moines River (DW15)
Companies: Coal fired power plants
Possible contaminants:

- 2 storage tanks
- Combustion byproducts
- Metals
- Fuel oil
- PCBs

Location of concern: W. 1st and 2nd St. and W. Market St. (DW16)
Companies: S. Green and Sons Foundry
Kratzer Carriage Co
Friction Proof Lubricant Co.
Des Moines Fuel and Feed Co
Ink Manufacturing Co
Possible Contaminants:

- PCBs
- Metals
- Lubricants

Additional Concerns:
The following sites were listed as ERS sites but not explained in the report.

CERCLIS Sites:
- 7th St. Lead- refer to review of Birdland Park Levee
- Irwin Chemical (DW17)
- Tuttle St. Landfill (DW18)
- Iowa Sanitation Environmental, Inc. (DW19)
- Harriett St. Landfill (DW20)

RCRIS- Small Quantity Producers
- Des Moincs Vetcrans Auditorium
- Midtown Auto Repair
- Ramsey Pontiac Subaru
- Penske Truck Leasing
- Adhesive Compounders
- Industrial Strip Centers
- Des Moines Area Transit

NFRAP
- Two Rivers Service Center

RAATS
- Mercy Hospital Medical Center

FINDS
- Des Moines Veterans Auditorium
- Midtown Auto Repair
- Ramsey Pontiac Subaru
- Penske Truck Leasing Co
- Nesbitt Distributing
- Mercury Tool and Engineering
- Adhesive Compounders
- Industrial Strip Center
- Des Moincs Metro Transit
- Edwards Graphic Arts, Inc.

In addition, there are 33 UST and 27 LUST sites near the levee. A complete list can be found Section 3 of the report.

Appendix G
Iowa Department of Natural Resources Coordination

Fields of Opportunities

STATE OF IOWA

THOMAS J. VILSACK, GOVERNOR
SALLY J. PEDERSON, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
JEFFREY R. VONK, DIRECTOR

February 7, 2005

Dave McGuffin
City Hall
400 East 1st street
Des Moines, IA 50309-4112

RE: Levee Phase II ESA

Dear Mr. McGuffin:

The Iowa Department of Natural Resources has reviewed the following reports submitted under the levee project for flood damage reduction for the Des Moines and Raccoon Rivers in Des Moines, Iowa. The levees are described as follows:

Birdland Park Levee
Central Place Levee
Downtown East Levee
Downtown West Levee
Harriet Street Landfill Levee

The reviews concentrated on the levees and not on adjacent properties that might impact the levees. Our review showed that soil samples from the levee sites showed slightly elevated heavy metal and benzo(a)pyrene levels in soil. The heavy metal levels generally were within background levels that would be found in Iowa. There was little groundwater and this tended to indicate minimal contaminant levels.

Based on the information provided the department is of the view that these sites present minimal threat to human health and the environment and, therefore, no further investigation is required. The department reserves the right to require additional investigation if future information warrants such action.

If you have any questions, please contact me at 515-281-4117.

Sincerely,

Lambert A. Nnadi
Environmental Specialist Snr., Contaminated Sites Section

WALLACE STATE OFFICE BUILDING / 502 EAST 9th STREET / DES MOINES, IOWA 50319
515-281-5918 TDD 515-242-5967 FAX 515-281-8794 www.iowadnr.com

Appendix E-H
City Of Des Moines Sewer Project

CONVERSATION RECORD	TIME 10:30	DATE February 24, 2005

TYPE: [ ] VISIT [ ] CONFERENCE [x] TELEPHONE — [x] INCOMING [ ] OUTGOING

Location of Visit/Conference:

ROUTINE: NAME/SYMBO | INI

NAME OF PERSON(S) CONTACTED OR IN CONTACT WITH YOU	ORGANIZATION (Office, dept., bureau, etc.)	TELEPHONE NO:
Sara Thies	City of Des Moines	515-323-8173

SUBJECT
Des Moines and Raccoon River Hazardous, Toxic and Radioactive Waste Investigation

SUMMARY

Background: Extensive Phase I and Phase II HTRW sampling and analysis has occurred over the past several years for the Des Moines and Raccoon River Flood Damage Reduction Study and the Des Moines Riverwalk. These assessments determined that several areas along the levees were contaminated. Corps regulations require that work at contaminated areas be avoided, and when avoidance is not possible, for cost share projects, the area shall be remediated by the sponsor before the Corps project continues. One area, located on the west bank of the Des Moines River, had required further investigation (the area was identified as having environmental concerns in the Phase I Assessments, but further evaluation was halted due to City construction activities for an underground sewer line).

Email messages and the phone conversation with Sara Thies determined the following: The Iowa Department of Transportation had administered a project in Des Moines, referred to as the "Birds Run Outlet Storm Sewer Project." The work occurred in 2003 and 2004 during the construction season. In order to replace the sewer line, at least 20 feet of material was excavated near the areas proposed for Corps activities. The material was primarily rubble, and was removed off-site. Clean, manufactured sand was brought on site, and used as backfill. Corps levee activities were not anticipated to perform work as deep as 20 feet. Therefore, it does not appear that there are any further HTRW concerns with this site location.

ACTION REQUIRED
Update HTRW report and Feasibility Report. Contact Des Moines Greenbelt POC to pass on information (Amy Moore).

NAME OF PERSON DOCUMENTING CONVERSATION	SIGNATURE	DATE
Kara Mitvalsky, P.E.		2/24/05

ACTION TAKEN
Email sent to Dennis Hamilton, Amy Moore, Steve Russel, and Dan Johnson.

SIGNATURE	TITLE	DATE
Kara N. Mitvalsky, P.E.	Environmental Engineer	2/24/05

CONVERSATION RECORD — OPTIONAL FORM 271 (12-76) DEPARTMENT OF DEFENSE

Appendix E-I
Plates

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Downtown East Sample Plan	PLATE 5
Downtown West Sample Plan	PLATE 6
Borrow Area Sample Plan	PLATE 7

DES MOINES/RACCOON RIVERS FEASIBILITY REPORT
DES MOINES/RACCOON RIVERS STUDY
POLK COUNTY, IOWA

APPENDIX F

REAL ESTATE PLAN

APPENDIX F

REAL ESTATE PLAN
DES MOINES/RACCOON RIVERS FEASIBILITY REPORT
DES MOINES/RACCOON RIVERS STUDY
POLK COUNTY, IOWA

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APPENDIX F

REAL ESTATE PLAN
BIRDLAND PARK LEVEE

1. Birdland Park Levee Purpose

This Real Estate Plan supports the Des Moines/Raccoon Rivers Study Feasibility Report. This proposed project study area is located within Polk County in Central Iowa. The Des Moines River has approximately 6,250 square miles of watershed meandering downstream through Des Moines, Iowa which affect the Birdland Park Levee Project area. The project area is identified in Section II of this report.

The features for this project area will be to restore and raise the existing levee height to the new proposed flood control level and to build a new levee section (north end) to the new flood control height. From the 6th Avenue Bridge north to the existing recreational trail will be replaced with a new recreational trail. The existing sponsor owned levee right-of-way will receive no LER in accordance with ER 405-1-12, Chapter 12-38 which states:

"12-38. Exceptions to LER Credit. As a matter of policy, a non-Federal sponsor will not be afforded credit for the following categories of LER required for a project. Further, for projects that include LER value as a part of shared total project costs, the value amount that is non-creditable must be excluded from total project costs. Requests for exceptions to this policy together with persuasive rationale must be forwarded through Division to HQUSACE (ATTN: CERE-AP) for coordination and final determination. a. Previously Provided as an Item of Cooperation. The non-Federal sponsor shall not receive credit for the value of any LER, including incidental costs, that have been provided previously as an item of cooperation for another Federal project." ER 405-1-12

The City of Des Moines, Iowa is the non-federal sponsor for this project. The non-federal sponsor shall not receive credit for value of any LER, including incidental costs, that has been provided as an item of cooperation for another Federal project.

A. Description of Lands, Easements, and Right-of-Way (LER) Required for Construction, Operation and Maintenance of the Project

The proposed study areas are located within Polk County, Iowa. Maps depicting the proposed study areas are included as Exhibits "A", "B" and "C."

Total acres needed for the project is 49.57 acres. Of those total acres, 49.07 acres are owned in fee by the sponsor and 0.50 acre will need to be acquired in fee by the sponsor. Of the 49.07 acres, 26.47 acres (existing levee right-of-way) are not eligible for LER credit, and 22.60 acres (temporary work area, temporary borrow and fee mitigation site) are eligible for credit by the sponsor. The following is a breakdown of the 23.10 creditable acres needed for the project, to include the location, the type and numbers of properties affected by the proposed project, the acreage required, and the proposed estates for each of the individual area.

1. Type and Number of Properties Affected by Proposed Project

TYPE	NUMBER OF OWNERS	NUMBER OF TRACTS
COMMERCIAL	2	2
AGRICULTURAL	0	0
RESIDENTIAL	0	0
OTHER – School District	1	1
OTHER - City of Des Moines (existing levee right-of-way, mitigation, work area, and borrow sites)	1	1
TOTAL	**4**	**4**

2. Acreage and Estates Required

	Acres
Temporary Work Area Easement	3.22 acres
Temporary Borrow Area Easement	2.00 acres
Fee (Mitigation)	17.376 acres
Fee (Levee Right-of-Way)	7.06 acres

3. Location

The Birdland Park Levee Project area is located in Sections 27, 34 and 35, Township 79 North, Range 24 West of the 5th Principal Meridian. The borrow area is located in Sections 8 and 9, Township 78 N, Range 24W of the 5th Principal Meridian and the mitigation area is located in Sections 10 and 15, Township 80 North, Range 22 West of the 5th Principal Meridian, all within Polk County, Iowa

A map depicting the levee project area is included as Exhibit "A." A map depicting the borrow area is included as Exhibit "B," and a map depicting the mitigation area is included as Exhibit "C" – Des Moines/Raccoon Rivers Study – Birdland Park Levee.

4. Summary of Estates Required

a) Temporary Work Area Easement

A Temporary Work Area Easement is required over approximately 3.22 acres. This easement is needed for the Birdland Park Levee area and is highlighted in blue on the attached Exhibit "A," Project Maps. The following is the standard estate set forth in ER 405-1-12 that will be acquired:

b) Temporary Work Area Easement Estate

A temporary easement and right-of-way in, on, over and across (the land described in Schedule __) (Tract Nos. ___, ___ and ___), for a period not to exceed _____, beginning with date possession of the land is granted to the United States, for use by the United states, its representatives, agents, and contractors as a work area, including the right to move, store and remove equipment and supplies, and erect and remove temporary structures on land and to perform any other work necessary and incident to the construction of the Des Moines and Raccoon River Flood Damage Reduction Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs

and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

c) Temporary Borrow Area Easement

A Temporary Borrow Area Easement is required over approximately 2.00 acres. This borrow easement is needed for the Birdland Park Levee area and is highlighted in red on the attached Exhibit "B," Project Map. The following is the standard estate set forth in ER 405-1-12 that will be acquired:

d) Temporary Borrow Area Easement Estate

A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) (Tract Nos. ___, ___ and ___), for a period not to exceed_____, beginning with date possession of the land is granted to the United States, for use by the United states, its representatives, agents, and contractors as a (borrow area) (work area), including the right to (borrow and/or deposit fill, spoil and waste material thereon) (move, store and remove equipment and supplies, erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the _____Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and other vegetation, structures, or obstacles within the limits of right-of-way; reserving however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

e) Fee Simple Title for Levee Right-of-Way

Fee is required over approximately 7.06 acre. It is highlighted in green on the attached Exhibit "A," Project Maps.

f) Fee Simple Title for Mitigation

Fee is also required over approximately 17.376 acres for mitigation purposes (please see mitigation section of this report) and is highlighted in red on the attached Exhibit "C," Project Map.

The fee simple title to (the land described in Schedule A) 1/ (Tracts Nos. ____, ___, and ___), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines. 2/

g) Non-Creditable Land

The existing non-federal levee, 26.47 acres, had federal funds spent to upgrade features after the 1993 flood and therefore is not eligible for LER credit.

B. Ownership Discussion

This Birdland Park Levee Project area is owned by the sponsor, with the exception of three small parcels at the north end of the levee system owned by Des Moines Cold Storage Company, Consolidated Supply Inc. and the Des Moines Public School District. The sponsor will have to acquire fee simple title over these parcels due to the fact that a recreational trail will be built on top of the project levee in this area.

C. Land Values

A land value estimate was prepared by Ron Williams, CEMVR-RE-P and is dated 22 April 2004. The land value estimate was approved by Mr. Elwin Yoder, Chief, Appraisal Branch. Land values are discussed in the Baseline Cost Estimate, paragraph 1.K..

D. Summary of LER required for the Des Moines/Raccoon Rivers Study Project

(1) Four Total Ownerships Affected

(2) Total Acre Required (Temporary Work Area Levee Easement)	3.22 acres
(3) Total Acres Required (Temporary Borrow Area Easement)	2.00 acres
(4) Total Acres Required (Fee for additional levee Right-of-Way)	7.06 acres
(5) Total Acres Required (Fee for Mitigation)	17.376 acres
(6) Total Acres Non-creditable	26.47 acres

E. Lands Required Owned By Sponsor

The project sponsor, The City of Des Moines, Iowa, owns the lands required for the project except for three small parcels that the sponsor will have to acquire in fee simple title. This is because there will be a recreational trail on that section of project levee.

F. Non-Standard Estate Discussion

There are no Non-Standard Estates required for this project.

G. Federal Project within the LER required for the Project

After the 1993 flood, FEMA and the City of Des Moines upgraded the pump stations on the Birdland Park Levee receiving federal funds.

H. Federally Owned land required for Project

There are no federally-owned lands required for the project.

I. Navigational Servitude

Navigational Servitude does not apply and will not be exercised for this project.

J. Map Depicting the Area.

Project maps depicting the project areas are attached as Exhibits "A," "B," and "C."

K. Possibility of Induced Flooding Due to Project

There is no possibility that induced flooding will be caused within the project areas.

Baseline Cost Estimate

NON FEDERAL		FEDERAL
01 Lands & Damages (includes contingences and severance)	$500,000	$0
01 Relocation Assistance (PL 91-646)	$0	$0
01 Incidental Acquisition Costs (Itemized as follows)		
a. Monitoring LS Acquisition	$0	$40,000
b. Survey	$50,000	$0
c. Title Evidence	$20,000	$0
d. Negotiation/Closing	$15,000	$0
e. Appraisal	$10,000	$5,000
f. Attorney's Opinion of Compensability	$15,000	$0
TOTAL	**$610,000**	**$45,000**

L. Relocation Assistance Benefits

The project will not require relocations of homes, farms and businesses.

M. Mineral Activity/Timber Harvesting in Project Area

No mineral activity is known to exist in the areas of the project. There is no known timber harvesting in the project area that may affect the project.

N. Sponsor's Legal and Professional Capability to Acquire LER

The sponsor signed a Feasibility Cost Sharing Agreement on 13 September 1999. The sponsor will operate and maintain the completed project.

The sponsor has the legal capability and experience for, operation, and maintenance of the project. The assessment of the sponsor's capability is included as Exhibit D at the end of this Appendix.

The sponsor has been advised of the PL 91-646 responsibilities in acquiring the right-of-way for the project and has been advised of their responsibilities for documenting expenses for credit on the project. A Project Cooperation Agreement will be executed after project approval is received.

O. Zoning Ordinances Proposed

No known zoning ordinances are proposed.

P. Schedule of Land Acquisition Milestones

A detailed schedule will be developed when the final right-of-way (ROW) limits have been determined. The sponsor will need a minimum of 52 weeks to acquire the necessary ROW. Additional time may be required if condemnation is necessary. The following schedule will be completed after project approval.

Acquisition Schedule (schedule for typical acquisition project)

ROW Drawings Completed	12 weeks
Initiate Acquisition	8 weeks
Acquisition Complete	52 weeks
ROW Certificate	4 weeks

Q. Facility or Utility Relocations

The project will require relocations of water lines, sidewalks and driveways; therefore; there will be Public Law 91-646 Relocation Assistance Benefit payments allowed. An Attorneys Opinion of Compensability will be provided.

R. Impacts of Suspected or Known Contaminants

The Rock Island District conducted a Phase I and Phase IIA Hazardous, Toxic, and Radioactive Waste (HTRW) Environmental Site Assessment (ESA) for the Des Moines/Raccoon River Flood Damage Reduction Feasibility Study in accordance with Engineering Regulation (ER) 1165-2-132, HTRW Guidance for Civil Works Projects, and Engineering Regulations (ER) 405-1-12, Real Estate Handbook.

The assessment recognized environmental conditions in the following locations: Birdland Park, Central Place (including the mitigation site), Downtown West and Downtown East project areas. For more information, please consult the Phase I and Phase IIA HTRW and ESA included within this feasibility study report.

S. Landowners Support or Opposition to the Project

Public meetings have been held and landowners within the project area have been given the opportunity to express their interest in the proposed project. Landowner responses were favorable.

T. Risks of Acquiring Lands before Execution of the PCA

The Sponsor has been advised of the risks associated with acquiring land before execution of the Project Cooperation Agreement (PCA) IAW ER 405-1-12, Chapter 12. There are provisions in the Section 519 language of the Water Resources Development Act (WRDA) 2000 that state:

> *(A) VALUE OF LANDS.—If the Secretary determines that lands or interests in land acquired by a non-Federal interest, regardless of the date of acquisition, are integral to a project or activity carried out under this section, the Secretary may credit the value of the lands or interests in land toward the non-Federal share of the cost of the project or activity. Such value shall be determined by the Secretary. ER 405-1-12, Chapter 12.*

The sponsor currently owns existing levee right-of-way lands that apply to this provision except for three small parcels at the north end of the existing levee right-of-way. These will have to be acquired in fee simple due to the fact there will be a recreational trail in that location.

U. Other Real Estate Issues Relevant to the Project

The sponsor has a large Real Estate Department that is accustomed to acquiring property for other city projects. The Rock Island Real Estate staff spent a couple of days in the field working with the sponsor's real estate staff. The sponsor's staff appears to be more than capable of handling any real estate acquisitions, or other future unknown needs for this project.

APPENDIX F

REAL ESTATE PLAN
CENTRAL PLACE LEVEE

2. Central Place Levee Purpose

This Real Estate Plan supports the Des Moines/Raccoon Rivers Study Feasibility Report. This proposed project study area is located within Polk County in Central Iowa. The Des Moines River has approximately 6,250 square miles of watershed meandering downstream through Des Moines, Iowa which affects the Central Place Levee Project area. The project area is identified in Section II of this report:

The project feature for the Central Place Levee Project area will be to raise and restore the existing levee to the new flood control height. The existing sponsor owned levee right-of-way will receive no LEERD in accordance with ER 405-1-12 Chapter 12-38 which states:

"12-38. Exceptions to LER Credit. As a matter of policy, a non-Federal sponsor will not be afforded credit for the following categories of LER required for a project. Further, for projects that include LER value as a part of shared total project costs, the value amount that is non-creditable must be excluded from total project costs. Requests for exceptions to this policy together with persuasive rationale must be forwarded through Division to HQUSACE (ATTN: CERE-AP) for coordination and final determination. a. Previously Provided as an Item of Cooperation. The non-Federal sponsor shall not receive credit for the value of any LER, including incidental costs, that have been provided previously as an item of cooperation for another Federal project." ER 405-1-12

The non-federal sponsor shall not receive credit for value of any LER, including incidental costs, that has been provided as an item of cooperation for another Federal project. The City of Des Moines, Iowa is the sponsor for this project.

A. Description of Lands, Easements, and Right-of-Way (LER) Required for Construction, Operation and Maintenance of the Project

The proposed study area is located within Polk County, Iowa. A map depicting the proposed study area is included at Exhibit "A" and "B"

Total acres needed for the project is 34.28. Of this acreage, 34.18 acres are owned in fee by the sponsor and .095 acre will be acquired in easement for levee. Of the 34.18 acres, 18.59 acres (existing levee right-of-way) is not eligible for LER credit, and 15.69 acres (mitigation site, borrow site and easement for levee) are eligible for LER credit by the sponsor. The following is a breakdown of the 15.69 creditable acres needed for the project, to include the location, the type and numbers of properties affected by the proposed project, the acreage required, and the proposed estates for each of the individual area.

1. Type and Number of Properties Affected by Proposed Project

TYPE	NUMBER OF OWNERS	NUMBER OF TRACTS
COMMERCIAL	1	1
AGRICULTURAL	0	0
RESIDENTIAL	0	0
OTHER City of Des Moines (sponsor-owned levee right-of-way, borrow, and mitigation sites)	1	1
TOTAL	2	2

2. Acreage and Estate Required

Flood Protection Levee Easement 00.095 acre
Temporary Borrow Area Easement 00.500 acre
Fee (Mitigation) 15.090 acres

Location: The levee project and mitigation area is located in Sections 34 and 35, Township 79 North, Range 24 West of the 5th Principal Meridian, and the borrow is located in Section 8 and 9, Township 78 N, Range 24W of the 5th Principal Meridian all with Polk County, Iowa

A map depicting the levee project area is included as Exhibit "A" and a map depicting the borrow area is included as Exhibit "B" – Des Moines/Raccoon Rivers Study – Central Place Levee.

3. Summary of Estates Required

a) Flood Protection Levee Easement

A Flood Protection Levee Easement is required over approximately 0.095 acre. This easement is needed for the Central Place Levee area and is highlighted in green on the attached Exhibit "A." The following is the standard estate set forth in ER 405-1-12 that will be acquired

b) Flood Protection Levee Easement Estate

A perpetual and assignable right and easement in (the land described in Schedule __) (Tracts Nos. ___, ___ and ___) to construct, maintain, operate, patrol and replace a flood protection levee, including all appurtenances thereto; reserving, however, to the owner, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

c) Temporary Borrow Area Easement

A Temporary Borrow Area Easement is required over approximately 0.50 acres. This borrow easement is needed for the Central Place Levee area and is highlighted in red on the attached Exhibit "B," Project Map. The following is the standard estate set forth in ER 405-1-12 that will be acquired:

d) Temporary Borrow Area Easement Estate

A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) (Tract Nos. ___, ___ and ___), for a period not to exceed_____, beginning with date possession of the land is granted to the United States, for use by the United states, its representatives, agents, and contractors as a (borrow area) (work area), including the right to (borrow and/or deposit fill, spoil and waste material thereon) (move, store and remove equipment and supplies, erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the _____Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and other vegetation, structures, or obstacles within the limits of right-of-way; reserving however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines

e) Fee Simple Title for Mitigation

Fee is required over approximately 15.09 acres for mitigation purposes (please see mitigation section of this report) and is highlighted in blue on the attached Exhibit "A," Project Map.

The fee simple title to (the land described in Schedule A) 1/ (Tracts Nos. ____, ___, and ___), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

f) Non-Credible Land

The existing non-federal levee, 18.59 acres, had federal funds spent to upgrade features after the 1993 flood.

B. Ownership Discussion

This Central Place Levee Project area is owned by the sponsor, with the exception of a small parcel at the south end of the levee owned by Copperwood Partnership that will be needed to tie the levee into high ground. The sponsor will acquire a flood protection levee easement over this small parcel of land.

C. Land Values

A gross appraisal was prepared by Ron Williams, CEMVR-RE-P and is dated 20 April 2004. The appraisal was approved by Mr. Elwin Yoder, Chief, CEMVR-RE-P. Land values are discussed in the Baseline Cost Estimate, paragraph X.

D. Summary of LER required for the Des Moines/Raccoon Rivers Study Project:

(1) Total Ownerships Affected: Two

(2) Total Acre Required
(Flood Protection Levee Easement) 0.095

(3) Total Acres Required
(Temporary Borrow Area Easement) 0.50

(4) Total Acres Required
(Fee for Mitigation) 15.090

(5) Total Acres Non-credible 18.59 acres

E. Lands Required Owned By Sponsor

The project sponsor owns the lands required for the project, with the exception of one very small parcel over which they will have to acquire a flood protection levee easement over.

F. Non-Standard Estate Discussion

There are no Non-Standard Estates required for this project.

G. Federal Project within the LER required for the Project

There are no Federal projects within the LER required for this project.

H. Federally Owned land required for Project

There are no federally owned lands required for the project.

I. Navigational Servitude

Navigational Servitude does not apply and will not be exercised for this project.

J. Map Depicting the Area

Project maps depicting the project areas are attached as Exhibits "A" and "B."

K. Possibility of Induced Flooding Due to Project

There is no possibility that induced flooding will be caused within the project areas.

L. Baseline Cost Estimate

	NON FEDERAL	FEDERAL
01 Lands & Damages (includes contingencies and severance)	$110,000	$0
01 Relocation Assistance (PL 91-646)	$0	$0
01 Incidental Acquisition Costs (Itemized as follows)		
a. Monitoring LS Acquisition	$0	$20,000
b. Survey	$11,000	$0
c. Title Evidence	$4,000	$0
d. Negotiation/Closing	$3,500	$0
e. Appraisal	$6,000	$4,000
f. Attorney's Opinion of Compensability	$0	$5,000
TOTAL	$ 134,500	$29,000

M. Relocation Assistance Benefits

The Project will require relocations of sidewalk and driveways which do not qualify for Relocations Assistance Benefits; therefore there are not any Public Law 91-646 Relocation Assistance Benefit payments allowed.

N. Mineral Activity/Timber Harvesting in Project Area

No mineral activity is known to exist in the area of the project.

O. Sponsors Legal and Professional Capability to Acquire LER

The sponsor signed a Feasibility Cost Sharing Agreement on 13 September 1999. The sponsor will operate and maintain the completed project.

The sponsor has the legal capability and experience for, operation, and maintenance of the project. The assessment of the sponsor's capability is included as Exhibit "D." at the end of this Appendix.

The sponsor has been advised of the PL 91-646 responsibilities in acquiring the right-of-way for the project and has been advised of their responsibilities for documenting expenses for credit on the project. A Project Cooperation Agreement will be executed after project approval is received.

P. Zoning Ordinances Proposed

No known zoning ordinances are proposed.

Q. Schedule of Land Acquisition Milestones

A detailed schedule will be developed when the final right-of-way (ROW) limits have been determined. The sponsor will need a minimum of 52 weeks to acquire the necessary ROW. Additional time may be required if condemnation is necessary. The following schedule will be completed after project approval.

R. Acquisition Schedule (schedule for typical acquisition project)

ROW Drawings Completed	12 weeks
Initiate Acquisition	8 weeks
Acquisition Complete	52 weeks
ROW Certificate	4 weeks

S. Facility or Utility Relocations

There are currently no known planned facility or utility relocations.

T. Impacts of Suspected or Known Contaminants

The Rock Island District conducted a Phase 1 and Phase IIA Hazardous, Toxic, and Radioactive Waste (HTRW) Environmental Site Assessment (ESA) for the Des Moines/Raccoon River Flood Damage Reduction Feasibility Study in accordance with Engineering Regulation (ER) 1165-2-132, HTRW Guidance for Civil Works Projects, and Engineering Regulations (ER) 405-1-12, Real Estate Handbook.

The assessment recognized environmental conditions in the following locations: Birdland Park, Central Place (including the mitigation site), Downtown West and Downtown East project areas. For more information, please consult the Phase 1 and Phase IIA HTRW and ESA included within this feasibility study report.

U. Landowners Support or Opposition to the Project

Public meetings have been held and landowners within the project area have been given the opportunity to express their interest in the proposed project. Landowner responses were favorable.

V. Risks of Acquiring Lands before Execution of the PCA

The Sponsor has been advised of the risks associated with acquiring land before execution of the Project Cooperation Agreement (PCA) IAW ER 405-1-12, Chapter 12. There are provisions in the Section 519 language of the Water Resources Development Act (WRDA) 2000 that state:

> (A) VALUE OF LANDS.—If the Secretary determines that lands or interests in land acquired by a non-Federal interest, regardless of the date of acquisition, are integral to a project or activity carried out under this section, the Secretary may credit the value of the lands or interests in land toward the non-Federal share of the cost of the project or activity. Such value shall be determined by the Secretary.

The sponsor currently owns existing levee right-of-way lands that apply to this provision except for a very small parcel at the south end of the existing levee right-of-way which will have to be acquired under a flood protection easement.

W. Other Real Estate Issues Relevant to the Project

The sponsor has a large real estate department that is accustom to acquiring property for other City projects. Rock Island Real Estate staff spent a couple of day in the field reviewing the project with the sponsor's real estate staff. The sponsor's staff is more than capable of handling any real estate acquisitions or other future unknown needs for this project.

3. DOWNTOWN LEVEE CLOSURES

A. Downtown Levee Closures Purpose

This Real Estate Plan supports the Des Moines/Raccoon Rivers Study Feasibility Report. This proposed project study area is located within Polk County in Central Iowa. The Des Moines River has approximately 6,250 square miles of watershed and the Raccoon River has approximately 3,629 square miles of watershed meandering downstream through downtown Des Moines, Iowa in which both rivers affects the Downtown Levee Project area

The Downtown Levee Project is a Federal (Corps of Engineers) built levee system, built in the 1960s. The existing sponsor owned levee right-of-way will receive no LER in accordance with ER 405-1-12 Chapter 12-38 which states. The non-federal sponsor shall not receive credit for value of any LER, including incidental costs, that has been provided as an item of cooperation for another Federal project. .Project features for this project area will be to redo several street and railroad closures to make them more efficient and easier to close and maintain during emergency flood fighting situations. The total acreage involved in enclosure upgrading is 1.07 acres. City of Des Moines, Iowa is the sponsor for this project.

B. Description of Lands, Easements, and Right-of-Way (LER) Required for Construction, Operation and Maintenance of the Project

The downtown levee system was built in the 1960s as.a Federal built levee. LER for the fee land and acquired easements where credited at that time. The project sponsor, the City of Des Moines, Iowa, owns the lands required for the project (street/road) except for the railroads right-of-way in which the sponsor has adequate easement estates to upgrade and maintain those closures.

C. Non-Standard Estate Discussion

N/A.

D. Federal Project within the LER required for the Project

The existing Downtown Levee System Project was built with Federal money and is considered a Federal built levee project

E. Federally Owned land required for Project

There are no federally-owned lands required for the project.

F. Navigational Servitude

Navigational Servitude does not apply and will not be exercised for this project.

G. Map Depicting the Area

A project maps depicting the project areas is attached as Exhibits "A," "B," and "C." Colored in red is the enclosures that need to be upgraded.

H. Possibility of Induced Flooding Due to Project

There is no possibility that induced flooding will be caused within the project areas.

I. Baseline Cost Estimate

	NON FEDERAL	FEDERAL
01 Lands & Damages (includes contingences and severance)	$0	$0
01 Relocation Assistance (PL 91-646)	$0	$0
01 Incidental Acquisition Costs (Itemized as follows)		
a. Monitoring LS Acquisition	$0	$10,000
b. Survey	$7,500	$0
c. Title Evidence	$3,500	$0
d. Negotiation/Closing	$0	$0
e. Appraisal	$0	$0
f. Attorney's Opinion of Compensability	$0	$5,000
TOTAL	$ 11,000	$15,000

J. Relocation Assistance Benefits

The Project will require relocations of sidewalk and driveways which do not qualify for Relocations Assistance Benefits; therefore there are not any Public Law 91-646 Relocation Assistance Benefit payments allowed.

K. Mineral Activity/Timber Harvesting in Project Area

No mineral activity is known to exist in the area of the project. There is no known timber harvesting in the project area that may affect the project.

L. Sponsors Legal and Professional Capability to Acquire LER

The sponsor has the legal capability and experience for, operation, and maintenance of the project. The assessment of the sponsor's capability is included as Exhibit "D." at the end of this Appendix.

M. Zoning Ordinances Proposed

No known zoning ordnances are proposed.

N. Schedule of Land Acquisition Milestones

N/A

O. Facility or Utility Relocations

There are currently no known planned facility or utility relocations.

P. Impacts of Suspected or Known Contaminants

The Rock Island District conducted a Phase 1 and Phase IIA Hazardous, Toxic, and Radioactive Waste (HTRW) Environmental Site Assessment (ESA) for the Des Moines/Raccoon River Flood Damage Reduction Feasibility Study in accordance with Engineering Regulation (ER) 1165-2-132, HTRW Guidance for Civil Works Projects, and Engineering Regulations (ER) 405-1-12, Real Estate Handbook.

The assessment recognized environmental conditions in the following locations: Birdland Park, Central Place (including the mitigation site) , Downtown West and Downtown East project areas. For more information, please consult the Phase 1 and Phase IIA HTRW and ESA included within this feasibility study report.

Q. Landowners Support or Opposition to the Project

Public meetings have been held and landowners within the project area have been given the opportunity to express their interest in the proposed project. Landowner responses were favorable.

R. Risks of Acquiring Lands before Execution of the PCA

N/A

S. Other Real Estate Issues Relevant to the Project

There are no other relevant issues to this project.

RALPH J. WERTHMANN
Chief, Real Estate Division
Rock Island District

Des Moines/Raccoon River Flood Damage Reduction Project
SPONSOR: City of Des Moines, Iowa

ASSESSMENT OF NON-FEDERAL SPONSOR'S
REAL ESTATE CAPABILITY
(Per Appendix 12E, ER 405-1-12)

I. Legal Authority

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? Yes

b. Does the sponsor have the power of eminent domain for this project? Yes

c. Does sponsor have "quick take" authority for this project? Yes

d. Are any of the land/interests in land required for the project located outside the sponsor's political boundary? No

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? No.

II. Human Resource Requirements:

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of federal projects including P.L. 91-646, as amended? No

b. If the answer to II.a is "yes", has a reasonable plan been developed to provide such training?

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? Yes

d. Is the sponsor's projected in-house staffing level sufficient considering its other work load, if any, and the project schedule? Yes

e. Can the sponsor obtain contractor support, if required in a timely fashion? Yes

f. Will the sponsor likely request USACE assistance in acquiring real estate? (If "yes", provide description). No

DES MOINES/RACCOON RIVERS FEASIBILITY REPORT
DES MOINES/RACCOON RIVERS STUDY
POLK COUNTY, IOWA

APPENDIX G

ENVIRONMENTAL

DES MOINES AND RACCOON RIVERS
DES MOINES, IOWA

APPENDIX G

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FEASIBILITY REPORT

FLOOD DAMAGE REDUCTION
FOR DES MOINES AND RACCOON RIVERS PROJECT
DES MOINES, IOWA

WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

SECTION 1 COMPENSATORY WETLAND MITIGATION PLAN

Compensatory mitigation has been developed for this project due to unavoidable environmental impacts. These impacts have been avoided and minimized to the extent practicable, and unavoidable damages are expected to be compensated appropriately as described below. The avoidance and minimization took place during the planning process, since environmental impacts were considered when evaluating project alternatives. The Birdland reach alignment 3 was abandoned as the preferred alternative in part due to unacceptable environmental impacts associated with that alternative.

Approximately 1.4 to 2.3 acres of emergent wetlands, 2.7 to 3.8 acres of open water, 0.2 acres of bottomland forest, and 1.4 acres of upland forests would be impacted as a result of levee construction at the Birdland reach alignment 2 (Table 1). Central Place levee construction will result in a loss of approximately 1.2 acres of bottomland forest and 3.2 acres of upland forest. The loss of bottomland forest is a result of the clearing of this habitat within 15 feet of the proposed levee alignments and future levee maintenance. Two compensatory mitigation sites were selected for these environmental project impacts. Mitigation would be completed prior to or concurrent with project construction. Currently, the mitigation efforts are combined for the Birdland and Central Place wetland and forested upland impacts. If these two levee reaches need to be separated due to timing of construction of each levee reach or another unforeseen situation, the plan would be revised to allow for all impacts at each reach to be mitigated at the appropriate mitigation sites. There is enough area at both the Chichaqua and the Central Place mitigation sites to accommodate all necessary mitigation if the mitigation needs to be separated. The Birdland levee alignment may shift slightly during the plans and specifications phase of the study. The amount of mitigation acreage to be provided in that case will be based on the amount of wetland, open water, and upland forest impact associated with the final alignment, keeping the same compensation ratio as are currently described in this mitigation plan.

The Chichaqua mitigation site is owned by the City of Des Moines (City) and was purchased specifically to construct wetland mitigation projects. It is located within the larger Chichaqua Bottomlands area that is managed by the Polk County Conservation Board. A 20-acre mitigation site has already been constructed within the 85-acre parcel adjacent to this proposed mitigation plan.

Table 1: Mitigation Acres for Impacts at Birdland Park and Central Place

Habitat Types	Birdland Park Impacted Acres	Chichaqua [1] Mitigated Acres	Central Place Impacted Acres	Riverside of Levee [2] Mitigated Acres
Emergent Wetlands	1.4 to 2.3	2.8 to 4.6	0	0
Open water	2.7 to 3.8	2.7 to 3.8	0	0
Bottomland forest	0.2	0	1.2	2.6 [3]
Upland forest	1.4	6.4 [4]	3.2	2.2
Herbaceous buffer	0	1.2	0	0
Total Acres Impacted	10.1 to 12.1			
Total Acres of Mitigation	17.9 to 20.8			

[1] Chicaqua proposed wetland mitigation site, see Figure 8.
[2] Mitigtion site is riverside of the levee at Central Place, see Figure 13.
[3] 2.2. acres for Central Place & 0.4 acres for Birdland Park
[4] 2.6 Birdland Park & 3.8 Central Place

The total area to be used for the mitigation plan for this project would be approximately 17.9 -20.8 acres, see Table 1. The mitigation efforts at the Chichaqua site will be as follows:

Chichaqua Mitigation Site (acreage ranges)
2.8 – 4.6 acres of emergent wetland creation (Birdland Park Mitigation)
2.7 – 3.8 acres of open water creation (Birdland Park Mitigation)
6.4 acres of upland forest creation (Birdland Park Mitigation)
1.2 acres of herbaceous upland buffer (sediment runoff prevention)
13.1 – 16.0 Total acres used at Chachaqua mitigation site

The Central Place mitigation site is also owned by the City and is located riverward of the existing Central Place levee. The northern and southern ends of the levee are adjacent to uplands, and the central portion is adjacent to bottomland forest and wet meadows dominated by reed canarygrass between the levee and the Des Moines River. The mitigation efforts at Central Place will be as follows:

Riverside of Levee at Central Place Mitigation
2.2 acres of bottomland forest enhancement (Central Place Mitigation)
0.4 acres of bottomland forest enhancement (Birdland Park Mitigation)
2.2 acres of upland forest creation (Central Place Mitigation)
4.8 Total acres mitigation on the riverside of the levee at Central Place

Alternative mitigation sites were evaluated throughout the planning process. An interagency team made a site visit to a potential mitigation site in September, 2002, north of Euclid Avenue in Des Moines to evaluate the feasibility of performing wetland mitigation at a site

owned by the Rock Island Corps of Engineers (Corps) and leased by the Polk County Conservation Board. That site was determined to be unsuitable because it was primarily well vegetated with upland and wetland forest and emergent wetland species.

An interagency team also made a site visit to Soldier's Park and a soccer field site near Concord Street in southern Des Moines to evaluate the feasibility of wetland mitigation at those sites. These sites were determined to be unsuitable because the soccer fields had no unused areas large enough to convert to a mitigation site, and the park site is located on a hillside with little topsoil, and would be susceptible to erosion from upslope development. It is also in an area that could be developed by the City of Des Moines in the future. No other potential mitigation sites were identified by the Corps of Engineers or the City of Des Moines.

A habitat evaluation team was formed consisting of U.S Fish and Wildlife Service (USFWS), Iowa Department of Natural Resources (IDNR), and Corps biologists. The team conducted an on-site investigation, which included discussion of the existing emergent wetland habitat functions, values, and likelihood of mitigation success. Corps planning guidance methodology states that habitat-based evaluations (e.g. EXHEP, WHAG, etc.) should be used to the extent possible to evaluate ecological resources and impacts associated with Corps projects. However, because of the multiple numbers of impacted sites (18-23), their very small size (0.1 acre or less), and differing habitat types of wetlands involved, the team deemed that it would not be practicable to use any of those more formal evaluation approaches. Instead, the team relied on professional judgment for their evaluation process.

The team determined that the existing emergent wetlands have relatively high values and functions due to their natural setting, connectivity to open water, and presence within the aquatic ecosystem. Additionally, established marshland and bottomland hardwoods along an urban setting have an increased value because of their higher habitat or "carrying capacity" over nearby developed neighborhoods, the many years required to replace habitat lost by the removal of functioning marshland and mature trees, and fragmentation created by construction of the project through established wetland areas. It is estimated that the maximum impact could be as little as 10.1 acres to as much as 12.1 acres of a combination of emergent wetlands, bottomland forest, open water, and upland forest. The team determined that adequate compensation for impacts would require a mitigation site of approximately 17.9 acres for minimum impacts and 20.8 acres for the maximum. As such, the District is following mitigation guidance given in ER1105-2-100 and the USFWS's minimum mitigation requirement as stated in their draft Fish and Wildlife Coordination Act Report.

A cost comparison of mitigation costs of three alternatives can be found in the main report (Table 10). The level of effort expended to evaluate mitigation alternatives is consistent with the scope of the mitigation needs in light of the overall project. The costs for each mitigation feature are as follows:

Emergent wetland, open water creation, and upland buffer:
$116,513, or approximately *$33,289 per acre*

1.69 Average Annual Habitat Units (AAHUs) of bottomland forest enhancement:
$39,186, or approximately *$23,187 per AAHU*
(Note: there is a net gain of 0.29 AAHUs after 1.4 AAHU project impact)

5.42 AAHUs of upland forest creation:
$111,582, or approximately *$20,587 per AAHU*
(Note: there is a net gain of 2.52 AAHUs after 2.9 AAHU project impact)

An incremental cost analysis was carried out to determine the best buy options for wetland and upland forest mitigation (Table 2). For upland and bottomland mast trees, the cost analysis showed that bare root saplings were the least cost per acre. However, considering survivability (especially in the bottomland areas of Central Place) and years to desired output, it is recommended that root production method (RPM^{TM}) trees be used on all mitigation areas were mast production is desired. The RPM produces a tree which has been proven to be far superior to other nursery grown tree in regards to survival once planted on District project lands (Joe Lundh [MVR forester] pers. comm.). For wetland plantings, the cost analysis showed that broadcast seeding was the least cost per acre. The initial cost of plugs – which includes materials, equipment, and labor – far exceeds the cost of broadcast seeding. Although survivability of broadcasting wetland seed is predicted to be relatively low, maintenance and yearly re-broadcasting is the preferred best buy. Drilling seed to establish grasses/prairie is the preferred alternative for the establishment of herbaceous buffer zones. Based primarily on the number of years to desired output, this is in agreement with other prairie projects within the Rock Island District (Scott Rolfes [MVR biologist] pers. comm.])

The above cost estimates are based on the costs for similar project features associated with District ecosystem restoration projects involving construction of wetlands, open water areas, and upland and wetland forest. The selected mitigation plan provides a net gain in AAHUs and adequate replacement of wetland and open water functions and values that would otherwise be lost as a result of project impacts, in accordance with mitigation planning efforts involving an interagency team. Any reductions in the mitigation effort would likely be seen as unacceptable by the natural resource agencies and would also likely not be consistent with mitigation guidance as provided in ER 1105-2-100.

Table 2: Incremental Cost Analysis for Compensatory Mitigation

Upland and Bottomland Mast Trees Cost/Acre	Root Production Method/acre	Years to desired output	Survivability %	Balled and burlap	Years to desired output	Survivability %	Bare root saplings/tree	Years to desired output	Survivability %	Seeding	Years to desired output	Survivability %
Mast Tree (material/labor/equip)	$5,566	3	0.90	$9,776	3	0.80	$1,211.00	5	0.50	$610.73	10	0.70
Tree mats and/or bed prep	$447			$235			$0.00			$898.64		
Maintenance cost (Average Annual)	$0			$64			$444.45			$444.45		
Replanting to ensure 80 survivability	$601			$0			$363.30			$0.00		
Total cost per acre/desired output	**$6,614**			**$10,204**			**$3,433.25**			**$5,953.87**		
Wetland Planting Cost/Acre	**Plugs**	**Years to desired output**	**Survivability %**	**Broadcast**	**Years to desired output**	**Survivability %**						
Emergent vegetation	$68,130	2	0.80	$2,141	10	0.20						
Site Prep	$0			$898.64								
Maintenance cost (Average Annual)	$0			$380								
Replanting to ensure 80 survivability	$1,866			$1,824								
Total cost per acre/desired output	**$69,996**			**$11,122**								
Grasses	**Sod**	**Years to desired output**	**Survivability %**	**Drilling**	**Years to desired output**	**Survivability %**	**Broadcast**	**Years to desired output**	**Survivability %**			
Grasses/Prairie Mix	$54,782	2	0.80	$2,419	3	0.50	$2,419	6	0.50			
Site Prep	$898.64			$0			$898.64					
Maintenance cost (Average Annual)	$444			$380			$380					
Replanting to ensure 80 survivability	$0			$726			$995					
Total cost per acre/desired output	**$56,570**			**$3,559**			**$5,598**					

1.1 PROPOSED CHICHAQUA SITE MITIGATION PLAN:

1.1.1 Goal:

To create an upland forest dominated by mast trees, a diverse emergent wetland, and an open water area to replace similar habitat to be impacted through construction of the Des Moines and Raccoon Rivers flood control project.

1.1.2 Objectives:

Create approximately 2.8-4.6 acres of emergent wetland through excavation to the seasonal high water table and planting with a native wetland seed mix.

Create approximately 2.7-3.8 acres of open water through excavation to a minimum of 2 feet below the elevation of the seasonal high water table.

Create approximately 6.4 acres of upland hardwood forest through placement of material excavated from the emergent and open water mitigation areas onto a portion of the mitigation site and planting of the area with mast trees and fruiting shrubs at a combined density of approximately 3 trees and shrubs per 30 square feet.

Create an approximately 1.2 acre buffer zone between the forested upland and the emergent wetland and open water area through planting of the buffer zone with native prairie species.

Ensure long-term success of the mitigation effort through monitoring and remediation efforts during the first five years after construction and through long-term management by the Polk County Conservation Board as part of the larger Chichaqua Bottoms restoration area.

1.1.3 Project features:

- Create a plan view engineering drawing to show the locations and topography of the proposed excavation areas, placement areas, and the location of vegetated buffer, with description of proposed construction methods.
- Determine elevation of seasonal high water table using on-site soil features and off-site reference wetlands.
- Excavate approximately 5.5 acres of upland and farmed wetland agricultural areas approximately 2 feet to reach the expected seasonal high water table.
- If topsoil depth is shallower than the excavation depth, stockpile topsoil on-site, overexcavated wetland and open water area by 6", and then replace 6" of topsoil over excavated site.
- Leave uneven bottom (1 foot variability) and side contours to simulate natural conditions. The minimum excavation would be 1 foot and the maximum excavation would be approximately 3 feet in order to achieve the variability in bottom elevations.
- Seed proposed emergent wetlands with native seed mix at a rate of approximately 10 pounds per acre.

- Stockpile excavated subsoil material separately from the excavated topsoil. Place excavated subsoil material to the northeast of the excavation area to provide an upland plateau for upland mast tree plantings.
- Plant hard mast trees and fruiting shrubs at a combined density of approximately 3 per 30 square feet.
- Maintain 50 foot buffer between created wetland and open water area and the proposed upland forest to the northeast.
- Seed 50 foot buffer with native seed mix at a rate of approximately 10 pounds of seeds per acre.
- Place entire mitigation and buffer area into permanent Conservation Easement.
- Monitor excavated area, planted area, and buffer for five years. Monitoring reports will be prepared annually, including:
    - 1) annual photos from the same locations (taken during the growing season);
    - 2) a description of the volunteer re-vegetation of the excavated area and upland planted area;
    - 3) a description of any invasive species such as reed canarygrass into excavated or upland planted area
    - 4) a description of the vegetative community within the buffer; and
    - 5) recommendations to increase functioning of mitigation site. A qualified biologist will perform the monitoring, and District biologists will review the monitoring reports each year. District biologists will recommend remediation efforts when needed.

- Remediation actions during the five-year monitoring period to meet the goals of the mitigation site include the periodic spraying of reed canarygrass or other invasive species volunteers into the mitigation site over the five-year monitoring period, additional excavation to increase hydrology within the wetlands or open water area, replanting of trees or shrubs to achieve an 80% survival rate by the third year of monitoring, and placement of silt fences and/or hay bales to prevent erosion from adjacent uplands into the excavated wetland and open water areas.

1.2 PROPOSED CENTRAL PLACE MITIGATION PLAN:

1.2.1 Goal:

To create an upland forest dominated by mast trees, and restore a reed canarygrass wet meadow to bottomland forest habitat dominated by mast trees to replace similar habitat to be impacted through construction of the Des Moines and Raccoon Rivers flood control project.

1.2.2 Objectives:

Create approximately 2.2 acres of upland forest habitat dominated by mast trees through the planting of mast trees and fruiting shrubs in a currently mowed upland area.

Restore approximately 2.6 acres of bottomland forest habitat dominated by mast trees through the control of the existing reed canarygrass and the planting of mast trees and fruiting shrubs in the existing wetland area.

Ensure long-term success of the mitigation effort through monitoring and remediation efforts during the first five years after construction.

1.2.3 Project Features:

- Create a plan view engineering drawing to show the locations and topography of the proposed upland and wetland planting areas, with a description of proposed construction methods.
- Plant hard mast trees and fruiting shrubs in upland and wetland forested areas each at a combined density of approximately 3 trees and shrubs per 30 square feet.
- Place upland and wetland planted areas into permanent Conservation Easement.
- A qualified biologist will monitor the planted area for five years. The annual monitoring reports once prepared will be reviewed by District biologists. The monitoring reports each year will include:
    - 1) annual photos from the same locations (taken during the growing season);
    - 2) a description of the survival of the trees and shrubs;
    - 3) a description of any volunteer vegetation of the planted area; and
    - 4) recommendations to increase functioning of the mitigation sites. District biologists will recommend remediation efforts when needed.
- Remediation actions during five-year monitoring period to meet goals of mitigation site may include the continued control of reed canarygrass or other invasive species, placement of silt fences and/or hay bales to control any erosion into the wetland planting area by the adjacent reconstructed levee, and the re-planting of the trees and shrubs if the survival does not exceed 80% by the third year of monitoring.

SECTION 2 CWA 401 WATER QUALITY CERTIFICATION

The District will apply for a Section 401 Water Quality Certificate from the State of Iowa Department of Natural Resources. It will be enclosed in this section when it is received.

SECTION 3 ENVIRONMENTAL IMPACTS AND COMPENSATORY MITIGATION HABITAT EVALUATION

3.1 INTRODUCTION

The plan formulation process for this project identified wetland and forest impacts associated with the various project alternatives. Compensatory mitigation alternatives were identified to replace the habitat to be lost through implementation of the preferred alternative at the Birdland and Central Place levee reaches. The Downtown closure structures do not have quantifiable environmental impacts since they are located mainly within previously developed areas. The mitigation plan in Section 1 of this appendix describes the environmental impacts and preferred mitigation alternative. This habitat evaluation summary describes the evaluation that was performed in order to ensure the adequacy of the mitigation in light of project impacts.

The habitat evaluation was performed with USFWS personnel, and was coordinated with the IDNR. These agencies had recommended that compensatory mitigation be performed in order to replace habitat lost through project impacts.

3.2 HABITAT EVALUATION TECHNIQUE

The habitat evaluation consisted of quantifying habitat units to be lost through project impacts and quantifying habitat units to be gained through compensatory mitigation. The goal was to achieve a net positive number of average annual habitat units, which would mean that the compensatory mitigation provides enough habitat units to offset the project impacts.

The Expert Habitat Evaluation Procedure (EXHEP) was the technique used to quantify the habitat units gained and lost. The Fox Squirrel is the indicator species chosen to represent the upland forest habitat to be impacted and mitigated, and the Northern Parula warbler is the indicator species chosen to represent the floodplain forest habitat to be impacted and mitigated. No indicator species was chosen to represent the non-forested wetland impacts since these impacts consisted of a series of very small wetland impacts and these wetlands varied in the type and amount of wildlife habitat and other functions and values that they provided. Instead, coordination with the USFWS and the IDNR resulted in the wetland mitigation plan as described in Section 1 of this appendix. The mitigation would be performed off-site and out-of-kind, so those factors as well as the wetland functions and values to be impacted were taken into account when determining the mitigation acreage. The wetland functions and values to be impacted are mainly wildlife habitat for birds, small

mammals, and amphibians, flood storage, sediment/toxicant retention, and passive recreation. The Chichaqua mitigation site was designed to replace these functions and values.

EXHEP is a computerized method developed to evaluate the quality and quantity of habitat as a means of accounting for fish and wildlife values. In EXHEP, the value of an area to a given species of wildlife is a product of the size of the area times the quality, or suitability, for that species. The quantity part of the formula is any measure of area that is appropriately sized for the particular study, which in this case is acres. The quality of the habitat is expressed as an index, called the Habitat Suitability Index or HSI. This index compares the value of the specific habitat under study to optimum values for the habitat variables important for the evaluated species. HSI models are used in EXHEP to estimate the value of the habitat within the study area for the selected species and determine the quality portion of the formula used to calculate Habitat Units (HUs). The models are formulas that express habitat quality as a function of several life requisite variables important to the subject species. The product of the quality and quantity measures represents habitat value, expressed in HUs.

Habitat unit gains or losses are annualized by summing HUs across all years in the period of analysis and dividing the total (cumulative HU) by the number of years in the economic life of the project. The result of this calculation is called Average Annual Habitat Units (AAHUs). For project planning and impact analysis, the period of analysis was established as 50 years. To facilitate comparison, target years were established at 0 (existing conditions), 1, 25, and 50 years.

3.3 DETERMINATION OF PROJECT IMPACTS

Two habitat types were evaluated using EXHEP—upland forest adjacent to the floodplain and bottomland forest within the floodplain. Approximately 4.6 acres of upland forest will be impacted by the preferred alternative levee reaches, and approximately 1.4 acres of bottomland forest will be impacted by the preferred alternative. These acreages are the quantity part of the equation used to determine Habitat Units. The quality part of the equation was determined by selecting species for each habitat type and determining the HSI values for the impact areas at the current time and up to 50 years from now.

The Fox Squirrel was chosen as the indicator species for the upland forest to be impacted. This species was chosen because it has two life requisite variables that are relevant to the primary forest impacts—woodland size class and mast production. The woodland size class variable represents the loss of the size of the trees to be impacted. The mast production variable represents the presence or absence of hard mast trees. Squirrels utilize hard mast as a food source, so it is representative of many other species that utilize hard mast trees. The existing upland forest to be impacted consists mainly of large, soft mast species, which is indicated by the Suitability Index (SI) values of 0.6 out of a maximum of 1 for the size class variable, and an SI value of 0.1 out of a maximum of 1 for the mast production variable.

At the current time (year 0), the HSI value for this species at the impact area is 0.43. This was multiplied by the area to be impacted of 4.6 acres to achieve the determination of 1.99

Habitat Units. Because the value of the forest is expected to improve over time, as the trees get larger within the forest, the HSI value at 25 and 50 years from now is 0.7, so the number of Habitat Units is raised to 3.22. This is for the without project alternative. The without project final Average Annual Habitat Units (AAHUs) is 2.90.

If the project were to be constructed, the HSI value would be reduced to zero at the impact area, since the upland forest is currently located along the levees to be reconstructed and mowed for the project life. No trees would be allowed to return to the levee, so the upland forest habitat would not be replaced on-site over time. Therefore, the number of Habitat Units is lowered to zero after project construction. The with-project final AAHUs is 0, so the net loss of AAHUs at the impact area is 2.90, which was derived from subtracting the with project final AAHUs (0) from the without project final AAHUs (2.90).

The Northern Parula warbler was chosen as the indicator species for the bottomland forest to be impacted. This species was chosen due to its need for large trees. The impacts to the existing bottomland forest will consist of removing all trees within the impact area, so the structure and size of the existing trees is the pertinent life requisite variable. The existing trees are very large, so at the current time (year 0), the HSI value for this species at the impact area is 1. This was multiplied by the area to be impacted of 1.4 acres to achieve the determination of 1.4 Habitat Units. The quality of bottomland forest was expected to remain the same through the 50-year period; therefore, the HSI value does not change over time. Therefore, the without-project final AAHU is 1.4.

If the project were to be constructed, the HSI value would be reduced to 0 at the project area, since the bottomland forest currently located adjacent to the existing levees would be cleared and mowed for the project life to prevent tree growth adjacent to the reconstructed levees. No trees would be allowed to return to the mowed area, so the bottomland forest habitat would be lost on-site. Therefore, the number of Habitat Units that would be present at the impact area after project construction would be 0. The with project final AAHUs is 0, so the net loss of AAHUs at the impact area is 1.4, which was derived from subtracting the with project final AAHUs (0) from the without project final AAHUs (1.4).

3.4 DETERMINATION OF MITIGATION BENEFITS

The upland forest mitigation areas are now either mowed grass areas or in agricultural production. Therefore, they do not currently have any habitat value for the Fox Squirrel, so the without project AAHU is 0.

The upland mitigation site is proposed to be planted with hard mast-producing trees, so over time the HSI values would be raised from 0 to 1.0 as those trees mature. Approximately 8.6 acres would be converted to upland forest, so the Habitat Units would range from 0 at year 1 after construction to 8.6 at year 50 after construction. The AAHUs would be 5.42 for the with project mitigation effort.

The bottomland forest mitigation areas are now vegetated with the invasive species reed canarygrass, and they would be expected to remain that way for at least the next 50 years.

Therefore they have no habitat for the Northern Parula and are not expected to gain habitat for that species, so the without project AAHU is 0.

The reed canarygrass areas are planned to be planted with hard mast-producing trees, so over time the HSI values would be raised from 0 to 1. Approximately 2.6 acres would be converted to bottomland forest, so the Habitat Units would range from 0.52 at year 1 after construction to 2.6 at year 50 after construction. The AAHUs would be 1.69 for the with project mitigation effort.

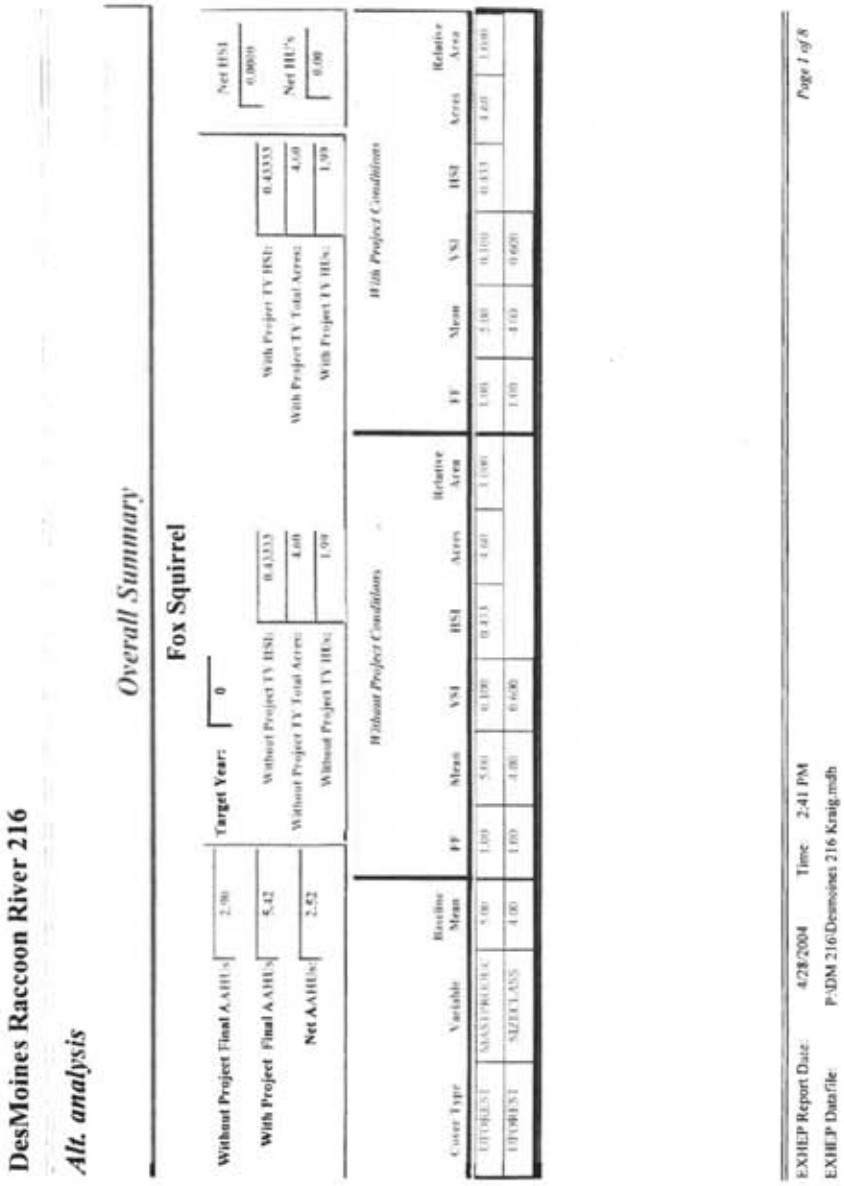
3.5 COMPARISON OF GAINS AND LOSSES

The upland forest would have without project final AAHUs of 2.90 and with project final AAHUs of 5.42 with compensatory mitigation. Therefore, there would be a net gain of 2.52 AAHUs over the 50-year period of analysis. This net benefit is consistent with the goals of the mitigation effort.

The bottomland forest would have without project final AAHUs of 1.4 and with project final AAHUs of 1.69 with compensatory mitigation. Therefore, there would be a net gain of 0.29 AAHUs over the 50-year period of analysis. This net benefit is consistent with the goals of the mitigation effort.

The attached Overall Summary tables for the Fox Squirrel and the Northern Parula show the acres, HSI values, and Habitat Units for the with and without project conditions for each target year.

The results of this EXHEP analysis are that the proposed mitigation effort adequately replaces the habitat to be lost through project construction.



DesMoines Raccoon River 216

Alt. analysis

Overall Summary

Fox Squirrel

Without Project Final AAHUs:	2.90	**Target Year:**	0			Net HSI	0.0000
With Project Final AAHUs:	5.42	Without Project TY HSI:	0.43333	With Project TY HSI:	0.43333		
Net AAHUs:	2.52	Without Project TY Total Acres:	4.60	With Project TY Total Acres:	4.60	Net HU's	0.00
		Without Project TY HUs:	1.99	With Project TY HUs:	1.99		

			Without Project Conditions						*With Project Conditions*					
Cover Type	Variable	Baseline Mean	FF	Mean	VSI	HSI	Acres	Relative Area	FF	Mean	VSI	HSI	Acres	Relative Area
UPOREST	MASTPRODUC	5.00	1.00	5.00	0.100	0.433	4.60	1.000	1.00	5.00	0.100	0.433	4.60	1.000
UPOREST	SIZECLASS	4.00	1.00	4.00	0.600				1.00	4.00	0.600			

EXHEP Report Date: 4/28/2004 Time: 2:41 PM

EXHEP Datafile: P:\DM 216\Desmoines 216 Kraig.mdb

Page 1 of 8

DesMoines Raccoon River 216

Alt. analysis

Overall Summary

Fox Squirrel

Without Project Final AAHUs	**2.90**	**Target Year:**	**1**			Net HSI	
With Project Final AAHUs	**5.42**	Without Project TY HSI:	0.43333	With Project TY HSI:	0.33333	-0.1000	
Net AAHUs:	**2.52**	Without Project TY Total Acres:	4.60	With Project TY Total Acres:	8.60	Net HU's	
		Without Project TY HUs:	1.99	With Project TY HUs:	2.87	0.87	

			Without Project Conditions						*With Project Conditions*					
Cover Type	Variable	Baseline Mean	FF	Mean	VSI	HSI	Acres	Relative Area	FF	Mean	VSI	HSI	Acres	Relative Area
UFOREST	MASTPRODUC	5.60	1.60	5.00	0.100	0.433	4.60	1.000	0.20	1.00	1.000	0.333	8.60	1.000
UFOREST	SIZECLASS	4.00	1.60	4.00	0.600				0.25	1.00	0.000			

DesMoines Raccoon River 216

Alt. analysis

Overall Summary

Fox Squirrel

Without Project Final AAHUs	2.90	**Target Year:**	25			Net HSI	-0.1000
With Project Final AAHUs	5.42	Without Project TY HSI:	0.70000	With Project TY HSI:	0.60000		
Net AAHUs:	2.52	Without Project TY Total Acres:	4.60	With Project TY Total Acres:	8.60	Net HU's	1.94
		Without Project TY HUs:	3.22	With Project TY HUs:	5.16		

			Without Project Conditions						*With Project Conditions*					
Cover Type	Variable	Baseline Mean	FF	Mean	VSI	HSI	Acres	Relative Area	FF	Mean	VSI	HSI	Acres	Relative Area
UFOREST	MASTPRODOR	5.00	1.00	5.00	0.100	0.700	4.60	1.000	0.20	1.00	1.000	0.693	8.60	1.000
UFOREST	SIZECLASS	4.00	1.25	5.00	1.000				0.75	3.00	0.100			

DesMoines Raccoon River 216

Alt. analysis

Overall Summary

Fox Squirrel

Without Project Final AAHUs	**2.90**	**Target Year:**	**50**			Net HSI	
With Project Final AAHUs	5.42	Without Project TY HSI:	0.70000	With Project TY HSI:	1.00000	0.50000	
Net AAHUs:	2.52	Without Project TY Total Acres:	4.60	With Project TY Total Acres:	8.60	Net HU's	
		Without Project TY HUs:	3.22	With Project TY HUs:	8.60	5.38	

			Without Project Conditions						*With Project Conditions*					
Cover Type	Variable	Baseline Mean	FF	Mean	VSI	HSI	Acres	Relative Area	FF	Mean	VSI	HSI	Acres	Relative Area
UFOREST	MASTPRODUC	5.69	1.10	5.00	0.100	0.700	4.60	1.000	0.20	1.00	1.000	1.000	8.60	1.000
UFOREST	SIZECLASS	4.69	1.25	5.00	1.000				1.25	5.00	1.000			

DesMoines Raccoon River 216

Alt. analysis

Overall Summary

Northern Parula

Without Project Final AAHUs:	1.40	Target Year:	0				**Net HSI**	0.0000
With Project Final AAHUs:	1.69	Without Project TY HSI:	1.00000	With Project TY HSI:	1.00000		**Net HU's**	0.00
Net AAHUs:	0.29	Without Project TY Total Acres:	1.40	With Project TY Total Acres:	1.40			
		Without Project TY HUs:	1.40	With Project TY HUs:	1.40			

			Without Project Conditions						*With Project Conditions*					
Cover Type	Variable	Baseline Mean	FF	Mean	VSI	HSI	Acres	Relative Area	FF	Mean	VSI	HSI	Acres	Relative Area
BFOREST	SIZECLASS	1.00	1.00	1.00	1.000	1.000	1.40	1.000	1.69	1.00	1.000	1.000	1.40	1.000

DesMoines Raccoon River 216

Alt. analysis

Overall Summary

Northern Parula

Without Project Final AAHUs:	1.40	Target Year:	1			Net HSI	-0.8000
With Project Final AAHUs:	1.69	Without Project TY HSI:	1.00000	With Project TY HSI:	0.20000		
Net AAHUs:	0.29	Without Project TY Total Acres:	1.40	With Project TY Total Acres:	2.60	Net HU's	-0.88
		Without Project TY HUs:	1.40	With Project TY HUs:	0.52		

			Without Project Conditions						*With Project Conditions*					
Cover Type	Variable	Baseline Mean	FF	Mean	VSI	HSI	Acres	Relative Area	FF	Mean	VSI	HSI	Acres	Relative Area
BFOREST	SIZECLASS	4.00	4.00	4.00	1.000	1.000	1.40	1.000	4.00	4.00	0.200	0.200	2.60	1.000

DesMoines Raccoon River 216

Alt. analysis

Overall Summary

Northern Parula

Without Project Final AAHUs:	1.40	Target Year:	25				Net HSI	
With Project Final AAHUs:	1.69	Without Project TY HSI:	1.00000	With Project TY HSI:	0.70000		-0.3000	
Net AAHUs:	0.29	Without Project TY Total Acres:	1.40	With Project TY Total Acres:	2.60		Net HU's	
		Without Project TY HUs:	1.40	With Project TY HUs:	1.82		0.42	

			Without Project Conditions						*With Project Conditions*					
Cover Type	Variable	Baseline Mean	FF	Mean	VSI	HSI	Acres	Relative Area	FF	Mean	VSI	HSI	Acres	Relative Area
BTOKEST	SIZECLASS	110	1.10	1.00	1.000	1.000	1.40	1.000	3.00	3.00	0.700	0.700	2.60	1.000

DesMoines Raccoon River 216

Alt. analysis

Overall Summary

Northern Parula

Without Project Final AAHUs:	1.40	Target Year:	50				Net HSI	0.0000
With Project Final AAHUs:	1.69	Without Project TY HSI:	1.00000	With Project TY HSI:	1.00000			
Net AAHUs:	0.29	Without Project TY Total Acres:	1.40	With Project TY Total Acres:	2.60		Net HU's	1.20
		Without Project TY HUs:	1.40	With Project TY HUs:	2.60			

			Without Project Conditions						*With Project Conditions*					
Cover Type	Variable	Baseline Mean	FF	Mean	VSI	HSI	Acres	Relative Area	FF	Mean	VSI	HSI	Acres	Relative Area
BFOREST	SIZECLASS	1.00	1.00	1.00	1.000	1.000	1.40	1.000	2.60	2.00	1.000	1.000	2.60	1.000

SECTION 5 FINDING OF NO SIGNIFICANT IMPACT

DES MOINES AND RACCOON RIVERS
FEASIBILITY STUDY
DES MOINES, IOWA

I have reviewed the information in this Integrated Environmental Assessment, along with data obtained from federal and state agencies having jurisdiction by law or special expertise, and from the interested public. I find that the construction of 500-year levees at Birdland and Central Place and the closure structures in downtown Des Moines would not significantly affect the quality of the human environment. The preferred alternative is the most feasible and practicable alternative to meet the project goals. Therefore, it is my determination that an EIS (Environmental Impact Statement) is not required. This determination will be reevaluated if warranted by later developments.

Alternatives considered along with the preferred action were:

Reach 1 Birdland Park
- No Action
- Birdland Alignment 1, Levees 100-, 250-, and 500-year
- Birdland Alignment 2, Levees 100- and 250-year
- Birdland Alignment 3, Levees 100-, 250-, and 500-year

Reach 2 Central Place
- No Action
- Levees 100- and 250-year

Reach 3 Downtown East
- No Action
- Raise existing 100-year levee to 500 year level of protection

Reach 4 Downtown West
- No Action
- Raise existing 100-year levee to 500 year level of protection

Reach 5 Downtown South
- No Action
- Raise existing 100-year levee to 500 year level of protection

Factors considered in making the determination that an EIS is not required are as follows:

- Approximately 2.8 to 4.6 acres of emergent wetlands will be created, 2.7 to 3.8 acres of open water will be created, and 2.6 acres of bottomland forest will be enhanced to offset the loss of the 1.4 to 2.3 acres of emergent wetland loss, 2.7 to 3.8 acres of permanent open water loss, and 1.4 acres of bottomland forested losses from levee reconstruction. Mitigation acreages will increase proportionally as needed to ensure adequate compensation for project impacts.
- Implementation of the preferred alternative would involve approximately 4.6 acres of upland forest impacts. Approximately 8.6 acres of upland forest is proposed to be planted in order to mitigate for those impacts.

- The proposed project would not significantly affect either water quality of the Des Moines River or cultural/historic resources.
- The proposed project will be further evaluated during the plans and specifications phase to determine the effect on federally listed endangered or threatened species. The District will coordinate with the US Fish and Wildlife Service as required in the Endangered Species Act if there is potential for negative effects to the Bald eagle and the Indiana bat. There will be no effect on state listed endangered or threatened species.
- Approximately 13 - 16 acres of farmland would be converted to emergent wetland and upland forest; this conversion is consistent with existing Natural Resources Conservation Service programs.
- The proposed project has identified and taken into account cumulative impacts and would not cumulatively exceed any known biological or social threshold.
- The Corps consulted with the State Historic Society of Iowa (SHSI), relevant Federally recognized tribes, and the interested public regarding this undertaking's potential effects on historic properties and particularly tribal concerns about properties that may be of religious and cultural significance (36CFR800.4(a)(3-4)). The SHSI concurred with the Corps determination of "No Effect" by letter dated August 9, 2004 and recommended a determination of "No Adverse Effect" for the remainder of the Area of Potential Effect (R&C#: 000377008). No additional historic properties or concerns were identified as a result of that consultation. The Otoe-Missouria Tribe notified the Corps by letter dated August 26, 2004 that they had no knowledge of properties within the project "Area of Potential Effect" but that they would like to be notified in the event of inadvertent discoveries during project construction. No additional historic properties or concerns were identified as a result of the consultation. It is the opinion of the Corps that this undertaking is in full compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations 36 CFR Part 800: "Protection of Historic Properties."

7 Sep 05
(Date)

for DUANE P. GAPINSKI
Colonel, U.S. Army
District Engineer

DES MOINES/RACCOON RIVERS FEASIBILITY REPORT
DES MOINES/RACCOON RIVERS STUDY
POLK COUNTY, IOWA

APPENDIX H

PUBLIC INVOLVEMENT

DES MOINES/RACCOON RIVERS FEASIBILITY REPORT
DES MOINES/RACCOON RIVERS STUDY
POLK COUNTY, IOWA

APPENDIX H

PUBLIC INVOLVEMENT

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APPENDIX H

PUBLIC INVOLVEMENT

Section 1 PUBLIC INVOLVEMENT

Throughout a feasibility study, the Corps of Engineers, Rock Island District (the District) 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. The goal of public involvement and coordination is to open and maintain channels of communication with the public in order to give full consideration to public views and information in the planning process (Engineer Regulation 1105-2-100, Appendix B – Public Involvement, Collaboration and Coordination).

An effective public involvement program must identify and respond to as many affected publics as possible throughout the study and consider their input in the study's decision-making process. 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.

Section 8 of the main report, "SUMMARY OF COORDINATION, PUBLIC VIEW, AND COMMENTS," summarized how public involvement played an important role in the Des Moines and Raccoon Rivers, Des Moines, Iowa, Feasibility Study process and had an influence on the study's recommended plan. The public involvement plan is described in more detail in this appendix.

Section 2 PUBLIC INVOLVEMENT PLAN

The public involvement plan for the study included the following techniques for providing information to the public and receiving feedback during the study: newsletters, website, and a public open house. The newsletters provided study information and points of contact for the public's questions/comments. The study website was created as a tool for additional information sharing. The open house was held to provide an opportunity for the public to meet one-on-one with the study team to discuss the study status and offer comments. These techniques are discussed in more detail below.

2.1 Newsletters

Four newsletters were developed and released during the study to a distribution list of approximately 300 individuals and organizations including elected congressional representatives; Federal, State, county, and city agencies; neighborhood associations; businesses; the media; and the unaffiliated general public. A copy of each newsletter can be found at the end of this appendix.

February 2000 – The first study newsletter described the study background, study areas, and provided a location map. The newsletter also provided names, addresses, phone numbers, and email addresses of City of Des Moines (the City) and District personnel who could be contacted if there were questions about the study.

January 2002 – The second study newsletter provided an update on the study's progress, announced that the aerial mapping was complete, and stated that a spring 2002 open house was planned (the open house did not occur until January 2003). The newsletter also provided the study's website address and points of contact.

December 2002 – The third study newsletter summarized the study's background and study progress on each of the 11 study area reaches, and invited the public to attend the January 2003 open house. Once more, the study's website address and points of contact were listed.

March 2004 – The fourth study newsletter described the District' six-step planning process, provided a study update, and summarized the January 2003 public open house. The newsletter also explained that work on the study was delayed due to funding issues. The study's website address and points of contact were again provided as a reference for all readers.

2.2 Website

The study's website was created to provide study information to all who have Internet access. The website was enhanced mid-way in the study to give the public access to a greater variety of study information as it became available. Examples of information shared on the website are study status, background, and schedule; study team members; and related documents and links. The website is located at http://www.mvr.usace.army.mil/DesMoinesFP/.

2.3 Public Views and Comments – January 2003 Open House

An invitation to attend a public open house was included in the study's December 2002 newsletter, which was mailed to approximately 300 individuals and agencies. A copy of the newsletter also was posted on the study's website. In addition, a news release announcing the open house was sent to media contacts in the study area. A copy of the news release is provided at the end of this appendix.

The purpose of the open house was for City and District personnel to meet one-on-one with the public to discuss the study. The study team provided information on the study status and the alternatives being evaluated for flood damage reduction in the various reaches within the study area. The public provided their input on the alternatives. In addition, the open house helped fulfill the National Environmental Policy Act's scoping requirements.

The open house was held at the Des Moines Botanical Center. Two identical sessions were held – one in the afternoon and one in the evening. The flexible timeframe allowed an opportunity for the attendees to come and go as they wished. Approximately 35 members of the public attended the open house, viewed the displays, and met with City and District study team members. Open house displays included a large map of the entire study area; maps of selected study reaches illustrating the 100-year floodplain; existing and potential levee alignments; and wetland locations; flood photographs; and a video of the 1993 flood event in the Des Moines area. A voiceless PowerPoint presentation provided a general study overview.

Open house attendees were asked to complete a comment sheet to provide input and express their concerns relating to the study. Following the open house, a content analysis report was prepared to document the proceedings and public comments and to analyze the information that was submitted. A copy of the content analysis report was distributed to all study team members for consideration and use in the analysis of the array of potential alternatives for the study areas. The open house

proceedings and content analysis report were summarized in the January 2004 newsletter and on the study's website.

Overall, comments were very favorable regarding the open house format and displays. Comments received at the public open house are summarized below:

Concerning the environmental aspects of the study, study-area residents recognize the importance and challenge of balancing the protection of people and property with the protection of the ecosystem. The major concerns centered on impacts to wetlands and farmland, and reducing rainwater runoff.

Other issues offered by the public for the study team's consideration included levee improvements; especially in the Central Place and Birdland Park areas; limiting floodplain development; potential floodwater damage impacts downstream of Des Moines; protection of the downtown business district; and the handling of interior drainage problems.

Impacts and damages resulting from the 1993 flood event in Des Moines were a major impetus for the initiation of this study. When asked if the study was addressing those impacts and concerns, nearly all respondents agreed that the study appears to have identified areas in need of improvement, and the final outcome will determine if those needs are addressed.

Section 3 ENVIRONMENTAL ASSESSMENT INITIAL COORDINATION LETTER

An initial coordination letter was mailed to natural resource agencies on 12 February 2004 and to cultural resource agencies on 21 July 2004 to inform them of the various flood protection alternatives being considered and the potential environmental or cultural impacts involved with these alternatives. The District received three replies to the initial coordination letter mailed to natural resources agencies and two replies to the initial coordination letter mailed to the cultural resources agencies. These replies and the District's responses are as follows:

1. Keith Dohrmann, Policy and Coordination Section, Conservation and Recreation Division, IDNR, stated in a letter dated 10 March 2004 that there are no site-specific records of rare species or significant natural communities that would be impacted by this project as long as there are no disturbances to the riverbed at or below the ordinary high water line of the Des Moines or Raccoon Rivers. The letter also states that clearing, grading, or excavation of an area greater than or equal to 1 acre may require a storm water discharge permit from the Department.

Response: The District will apply for all required permits and will not begin work until all permits have been received.

2. Christine M. Schwake, Water Resources Section, (IDNR), stated in a letter dated 11 March 2004 that the District should consider mitigation within the Des Moines River watershed or explain in the Environmental Assessment why that is not practicable. In addition, the IDNR suggested increasing the mitigation ratio if the out-of-watershed mitigation site is used. They would also like the District to provide as much in-kind mitigation as possible, and state that best management practices should be incorporated into the work plans.

Response: The District searched for suitable mitigation sites within the Des Moines River watershed, but was unsuccessful; therefore, the mitigation will be performed at the out-of-watershed mitigation site. Approximately 2.8 acres of wetlands will be impacted and approximately 5.4 acres of wetlands will be created or enhanced as compensatory mitigation. Most of this is in-kind mitigation.

3. Richard C. Nelson, Supervisor, Rock Island Field Office, U.S. Fish and Wildlife Service, stated in a letter dated 26 May 2004 that the USFWS has no objection to the selection of the preferred alternative of improvements to the existing Birdland Park and Central Place levee systems, installation and construction of downtown closure structures, and implementation of the comprehensive mitigation plan on-site at Central Place and off-site at the Euclid mitigation area. It does feel, however, that completion of the project will have indirect impacts in the form of increased downstream flooding due to a loss of flood storage areas. In addition, it states that the project will result in further fragmentation of the remaining Des Moines River riparian corridor. The USFWS also recommended avoiding the large mature trees within Birdland Park that are used by wintering bald eagles.

Response: The cumulative impacts of the project are discussed in the main report in Section 6.B(4). The District will finalize the layout of the Birdland Park alignment in the Plans and Specifications phase of this project, and will work to avoid the large eagle-perching trees as much as possible.

4. Daniel Higginbottom Archaeologist, Iowa State Historic Preservation Office, State Historical Society of Iowa, stated in a letter dated 9 August 2004 that the society concurred with the District's determination of "No Effect" as it pertained to Reach 1, Reach 2, and those project features located outside of known historic district and individual historic property boundaries. The society a "No Adverse Effect" determination for those project features within known historic property boundaries in Reaches 3, 4, and 5.

Response: The District concurs with the State Historical Society of Iowa recommendations.

5. Mildred Hudson, NAGPRA Director, Otoe-Missouria Tribe, stated in a letter dated 26 August 2004 that they had no knowledge of properties within the project "Area of Potential Effect" but that they would like to be notified in the event of inadvertent discoveries during project construction.

Response: The District will notify the Otoe-Missouria Tribe of any relevant discoveries during project construction.

3.1 Environmental

CLINGERMAN/dmd/5791

February 12, 2004

Planning, Programs, and
Project Management Division

SEE DISTRIBUTION LIST

The Rock Island District of the U.S. Army Corps of Engineers (Corps) has identified the need to provide flood protection for the City of Des Moines, Polk County, Iowa. A feasibility study is currently underway to evaluate various flood protection alternatives. This project would be cost shared by the City of Des Moines.

The study area was divided into separable levee reaches. The Corps currently recommends construction of flood protection structures within three areas, including the Birdland Park levee reach, the Central Place levee reach, and the Downtown levee reaches, as deseribed below. The site location map for these three areas is enclosed (Enclosure 1).

a. The Corps recommends reconstruction of the existing levee at the Birdland Park reach. The existing levee requires upgrading to meet Corps flood protection levee standards. This work would involve reconstructing approximately 6,000 feet of the non-Federal levee, including adding an inspection trench and constructing a new upstream floodwall tie-off, interior drainage measures, street closure structures and other related structures and utility relocations. This construction project would permanently impact approximately 1.3 acres of emergent, scrub-shrub, and forested wetlands, as well as 1.6 acres of open water. A potential compensatory mitigation site has been identified, as shown on the enclosed map (Enclosure 2). Portions of the existing Birdland Park levee have an upland forested community present up to the top of the levee. Where the levee would be reconstructed in the same location, those forested areas would be cleared and maintained in a mowed state after construction. The Corps intends to mitigate for the lost forested habitat through tree plantings within the project area.

b. The Corps also recommends reconstruction of the existing levee at the Central Place reach. This levee is approximately 1.1 miles in length and does not meet minimum Corps standards for a certified levee system. The reconstructed levee would be in the same location as the existing, structurally unsound levee, so no permanent wetland impacts would occur. A forested wetland exists immediately adjacent to the levee, however, and an area approximately 15 feet wide from the base of the levee toward the Des Moines River would be cleared and kept in a short, mowed grass condition to prevent tree root damage to the levee in the future.

Compensatory mitigation for the approximately 1.8 acres of forested wetland impact is proposed through planting of trees within open areas of the existing reed canary grass dominated wetland between the levee and the Des Moines River. An upland forest community also exists along the levee slope, and this would be removed through construction of the new levee, which would be maintained in a mowed state in the future. The Corps intends to mitigate for the lost forested habitat through tree plantings within the project area.

c. The Downtown levee reaches include several existing "sand-bag" closure requirements. The Corps recommends improving these closure requirements or eliminating the closures by constructing permanent levee or floodwalls. The four downtown streets that cross the Des Moines River would be improved through the extension of the levees to the existing bridge abutments by constructing small sections of floodwall. This would minimize the closure requirements and allow the City to keep the streets open for a longer period of time during a major flood. Several railroads have been abandoned since construction of the initial levee projects in the late 1960s and early 1970s. The Corps recommends constructing permanent levee closures by constructing levee embankments or extending existing floodwalls. Other closure locations on the enclosed site map are improvements to minimize the existing closure by extending the levee or floodwall to reduce the opening. No wetland or forest impacts are anticipated for any of these closure proposals.

The Corps' Rock Island District plans to prepare an Environmental Assessment for this proposal. At this time we would like to identify any existing significant resources or other environmental concerns associated with this proposal, such as wetlands, endangered species, land-use plans, floodplain issues, etc. Please inform us of any reports, studies, or other research concerning environmental resources in the project vicinity that may be of use in analyzing potential impacts of the project.

Please provide any comments you may have regarding this proposal within 30 days of receipt of this letter. Address your comments, concerns, or questions to Ms. Gail Clingerman of our Economic and Environmental Analysis Branch, telephone 309/794-5791. Written comments may be sent to our address above, ATTN: Planning, Programs, and Project Management Division (Gail Clingerman).

Sincerely,

ORIGINAL SIGNED BY

Kenneth A. Barr
Chief, Economic and Environmental
Analysis Branch

Enclosures

CF (all w/encls):
Dist File (PM-M)
PM-A (Clingerman)
PM-A (Ross)
PM-M (Russell)
ED-DM (Cerny)
RE-A (Riddell)
OD-PE (Jones)

MFR: Coordination letter for proposed flood damage reduction project at the City of Des Moines.

DES MOINES 216 91P 26 JAN 04

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PAUL ZEPH
EXECUTIVE DIRECTOR
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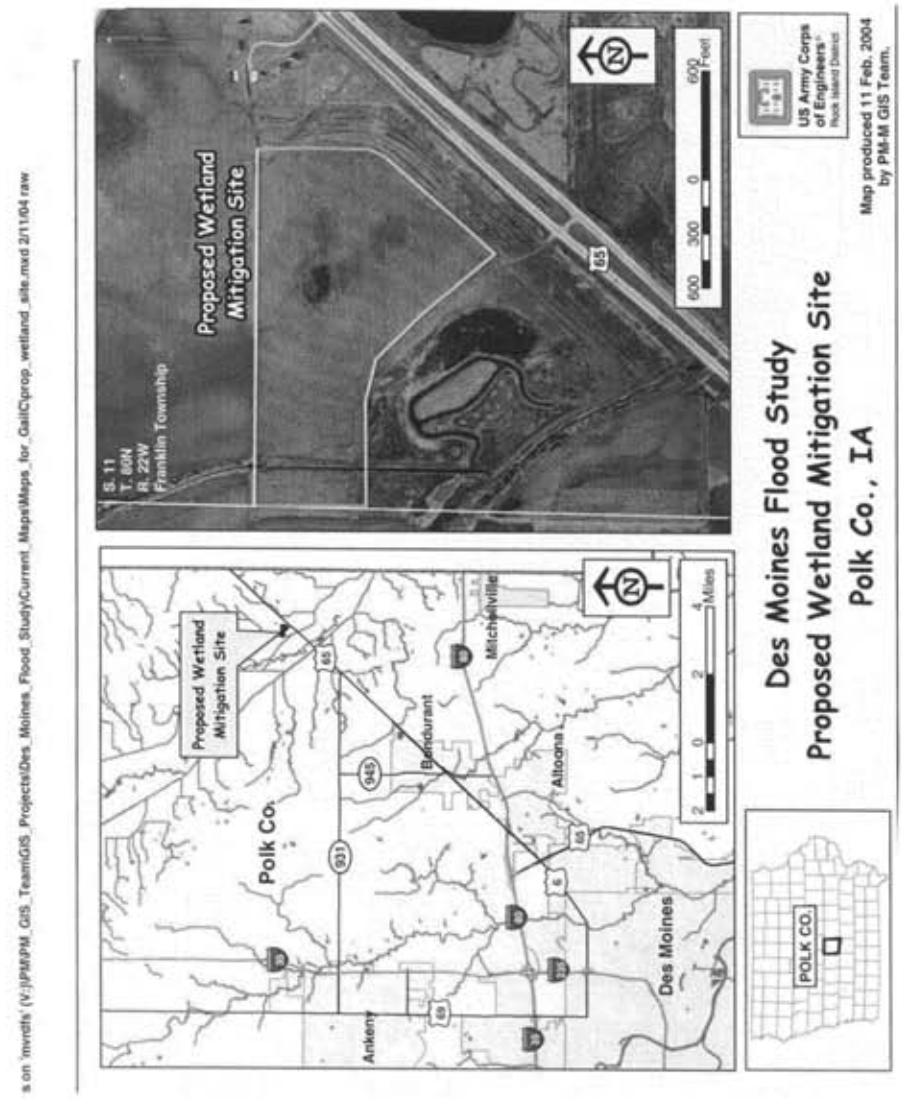
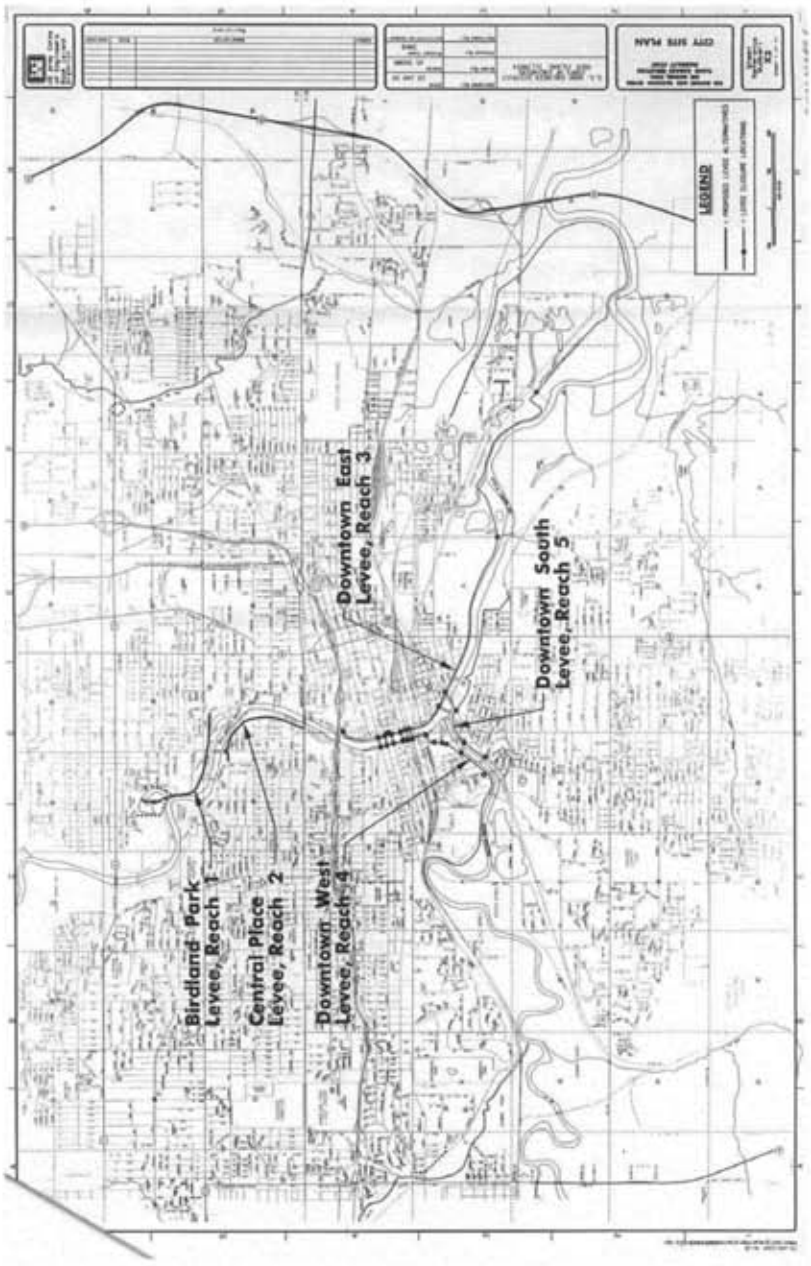

Des Moines Flood Study
Proposed Wetland Mitigation Site
Polk Co., IA
Proposed Wetland Mitigation Site
S. 11
T. 80N
R. 22W
Franklin Township
Polk Co.
Ankeny
Bondurant
Altoona
Mitchellville
Des Moines
POLK CO.
US Army Corps of Engineers
Map produced 11 Feb. 2004 by PM-M GIS Team.


CITY SITE PLAN
LEGEND
Birdland Park Levee, Reach 1
Central Place Levee, Reach 2
Downtown West Levee, Reach 4
Downtown East Levee, Reach 3
Downtown South Levee, Reach 5

H-10

3.2 Cultural

ROSS/vdc/5540

July 21, 2004

Planning, Programs, and
Project Management Division (1165-2-26a)

SEE DISTRIBUTION LIST

The Rock Island District of the U.S. Army Corps of Engineers (Corps) and the City of Des Moines, Iowa, are evaluating systemic, comprehensive flooding problems along the Des Moines and Raccoon Rivers and their tributaries within the city limits of Des Moines, in Polk County, Iowa. The Des Moines and Raccoon Rivers (DMRR) project is funded through the Energy and Water Development Appropriations Act of 1998, under the authority of Section 216 of the 1970 Flood Control Act.

Public Law 89-72 authorizes recreational features as a separable part of this project. These optional project features are to be cost-shared, with the City of Des Moines being responsible for 50 percent of implementation costs and 100 percent of operation, maintenance, and replacement costs, as defined in Public Law 99-662

Federal Undertaking

Pursuant to the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR Part 800, the Corps has determined that construction and wetland mitigation associated with the DMRR project has potential to cause effects to architectural and archeological historic properties [36 CFR 800.3(a)(1)] and as a consequence will require a determination of effect within the Area of Potential Effect (APE).

APE

The APE for the DMRR project is divided into five separate reaches and includes a combination of levee construction, levee improvement, closure construction, and bicycle trail construction (Exhibit 1). Reach 1 is the Birdland Park Levee and is located on the left descending bank of the Des Moines River in Sections 27, 34, and 35, Township 79N, Range 24W within the City of Des Moines, Polk County, Iowa (Exhibit 2). Project features in Reach 1 consist of levee improvement and levee construction that will require clearing, grubbing, tree removal, and inspection trench excavation. Impacts will not exceed 6 feet below surface. Bicycle trail construction is proposed for the top of the Birdland Park Levee and will be limited to the levee footprint.

Reach 2 is the Central Place levee and is located on the right descending bank of the Des Moines River in Sections 34 and 35, Township 79N, Range 24W and Sections 3 and 4, Township 78N, Range 24W within the City of Des Moines, Polk County, Iowa (Exhibit 3). Project features in Reach 2 consist of levee construction that will require clearing, grubbing, tree removal, and inspection trench excavation. Tree removal necessitates forested wetland mitigation which will be conducted riverward of the levee and involve mast tree plantation. Impacts from levee construction and wetland mitigation will not exceed 6 feet below surface.

Reach 3 is the Downtown East levee and is located on the left descending bank of the Des Moines River in Sections 3, 4, 10, 11, and 12, Township 78N, Range 24W within the City of Des Moines, Polk County, Iowa (Exhibit 4). Project features in Reach 3 include closure construction at 15 locations. Closures to be constructed include permanent closures (n=4), gate/stop log closures (n=4), seal gap closure (n=1), and reduced closures (n=6). Impacts will be limited to disturbed ground either within the existing levee footprint and immediately adjacent to and associated with existing structures including bridges, sidewalks, highway entrance ramp, roads, railroad bridges. Twelve of the closures are proposed within the Civic Center Historic District and adjacent to contributing resources. The impacts of these closures are discussed in more detail under the Identification of Historic Properties section below.

Reach 4 is the Downtown West levee and is located on the right descending bank of the Des Moines River in Sections 4 and 9, Township 78N, Range 24W and on the left descending bank of the Raccoon River in Sections 8 and 9, Township 78N, Range 24W within the City of Des Moines, Polk County, Iowa (Exhibit 4). Project features in Reach 4 include levee and floodwall closure construction at nine locations consisting of permanent closures (n=3), reduced closures (n=5), and a gate/panel closure (n=1). Impacts are similar to those identified for Reach 3 and include seven locations within the Civic Center Historic District and adjacent to contributing resources to that District and individually National Register of Historic Places (NRHP) eligible archeological site 13PK61. Again the impacts from these specific closures will be discussed in more detail under the Identification of Historic Properties section below.

Reach 5 is the Downtown South Levee and is located on the right descending bank of the Raccoon River in Sections 9 and 10, Township 78N, Range 24W and on the right descending bank of the Des Moines River in Sections 10 and 11, Township 78N, Range 24W within the City of Des Moines, Polk County, Iowa (Exhibit 4). Project features in Reach 5 are limited to levee closure construction at three locations. Impacts are similar to those identified for Reaches 3 and 4 with the exception that only a small portion of Reach 5 is located within the Civic Center Historic District and one of the proposed closures is located within the Civic Center Historic District.

Forested and emergent wetland mitigation will be required due to wetland impacts in Reaches 1 and 2 and is proposed at two separate locations totaling approximately 15 acres. The first location is the Euclid site, an 85-acre parcel currently owned by the project sponsor, as mitigation for most of the project impacts. This mitigation site is located within the larger Chichaqua Bottomlands Greenbelt, an approximately 7,000 acre area of marshes, forests, prairies, and oxbows being restored by a multi-agency effort led by the Polk County Conservation Board. Specifically, the Euclid mitigation area is located in the fractional Sections 10 and 11, Township 80 North, Range 22 West, Polk County, Iowa (Exhibit 5). Mitigation will also take place on the riverside of the levee in Reach 2 in the fractional Section 35, Township 79N, Range 24W, Polk County, Iowa (Exhibit 3). Impacts from wetland mitigation will consist of a combination of mast tree plantings, excavation, and inundation and are anticipated not to exceed one meter below surface.

Consulting Parties

The Corps finds the organizations identified on the Distribution List are entitled to be consulting parties, as set out in 36 CFR 800.2, and invites them by copy of this letter to participate in the Section 106 process.

State Historic Preservation Officer (SHPO) Invitation

The Corps invites the SHPO to:

- Identify any other consulting parties as per 36 CFR 800.3(f);
- Comment as per 36 CFR 800.2(d)(3) on the Corps' plan to involve the public by utilizing the Corps' normal procedures for public involvement under the National Environmental Policy Act (NEPA); and,
- Comment on or contribute to identification efforts including definition of the APE, all as per 36 CFR 800.4(a-b).

Identification of Historic Properties

Review of Existing Information and Level of Future Identification Efforts:

The District queried the most current version of the District Archeological Site and Survey Geographic Information Systems (GIS) data bases (current as of April 2004) and determined that there is one previously recorded archeological site within the project area. Reaches 1, 2, and 5 have not been surveyed previously and there are no previously recorded sites within the levee construction, closure construction, and/or wetland mitigation areas. Portions of Reaches 3 and 4 have been surveyed and one NRHP eligible archeological site, 13PK61, is located in Reach 4 and adjacent to the proposed railroad bridge closure structure.

Site 13PK61, Fort Des Moines No. 2, is a multi-component prehistoric and historic archeological site. Numerous investigations have evaluated portions of the site and it was formally determined eligible for inclusion on the NRHP in 2000. The most current site boundaries place the site from the river's edge to SW 7th Street and from Walnut Avenue south to Elm Street. A total of five closures are proposed within these site boundaries (Exhibit 12).

The Civic Center Historic District (CCHD) is a NRHP multiple property listing that is based on thematic areas of significance including architecture, community planning and development, and landscape architecture all dating from 1892 to 1938. The nomination includes seven contributing structures, six contributing buildings, and five noncontributing structures. There are twelve closures in Reach 3, seven closures in Reach 4, and one closure in Reach 5 that are located within the CCHD. Two of the proposed levee closures within the CCHD are adjacent to the Court Avenue Bridge, a contributing resource to the CCHD nomination.

The wetland mitigation project area located in the Chichaqua Wildlife Area has been subjected to surface survey and deep geomorphological investigation. Landform Sediment Assemblages (LSA) have been identified as part of a geoarchaeological model of a prehistoric site location model developed by the Office of the State Archaeologist (OSA) for the Chichaqua Wildlife Area (Artz 2003). The wetland mitigation area contains both Late Wisconsinan Outwash Terrace (WOUT) and Late Holocene Meanderbelt (LHOL) LSAs. The buried archeological potential has been characterized by the OSA as high on the low relief dunes in the WOUT LSA, low in the flood basin WOUT, and low-moderate in the LHOL LSA (Artz 2003:25).

A total of 26 closure structures are proposed. Each closure is identified by its reach, type of closure, location relative to historic properties, and Corps determination of effect in Exhibit 6. Detailed drawings of closure construction within the CCHD are provided in Exhibits 7-11. Note that closures will be necessary at the Des Moines Union Railway Bridge, an individually NRHP eligible architectural property located within the CCHD, however these closures will be constructed as part of a separate undertaking and will not be evaluated here.

Ground disturbance associated with all closure construction will be limited to previously disturbed ground associated with the existing facilities where the closure is proposed. The existing facilities include a combination of levees, flood walls, roads, railroad tracks, and bridges. The proposed closures include permanent closures (n=8), reduced closure openings (n=11), and enhanced closure openings (n=6). Permanent closures will include raising existing roads that cross levees to the levee height (n=2), tying existing levees to existing roads (n=1), and placing permanent closures across existing defunct railroads (n=5). Reduced closure openings

consist of extending existing levees and floodwalls to existing bridges and are designed essentially to reduce the amount of time needed to barricade an opening in an emergency flooding situation. Enhanced closure openings involve modifying existing structures to accept stop log or panel structures in order to reduce the amount of time needed to barricade an opening during an emergency flooding situation.

The Corps has determined that all of the proposed closures are limited to disturbed ground and will have No Effect on archeological historic properties because of the minimal impact of the work. The closures as proposed will neither penetrate disturbed ground to impact unknown buried archeological deposits or any potential deposits associated with site 13PK61. In addition, the closures as proposed will have No Effect on the structural integrity of the Court Avenue Bridge or any of the other contributing resources defined in the CCHD multiple property listing. Finally, the Corps has determined that the closures as proposed will have No Effect on the visual integrity of the CCHD, its contributing resources, or the individually significant Des Moines Union Railway Bridge because the proposed structures are in keeping with existing facilities, such as levee and floodwall extensions, or they are minor and temporary nature, such as the reduced and enhanced closure openings.

The Corps determined that ground disturbance associated with work proposed at Reaches 1, 2, and associated wetland mitigation would require archeological evaluation and deep geomorphological assessment in order to assess the effects to archeological cultural resources. The Corps contracted with Great Lakes Archaeological Research Center under contract W912EK-04-D-0001 to conduct archeological survey with deep geomorphological assessment at the Birdland Park, Central Place, and wetland mitigation project areas. The investigation documented one archeological isolated find of unknown prehistoric affiliation and recommended that the cultural resource be determined ineligible for inclusion to the NRHP. In addition, the investigation recommended cultural resource management clearance for the remainder of the surveyed areas. The Corps concurred with that recommendation and provided the report with a determination of "No Historic Properties Effected" to the State Historical Society of Iowa (SHSI) by letter dated May 26, 2004. The SHSI concurred with that determination by letter dated June 17, 2004 (R&C#: 00377008).

It is the opinion of the Corps that the DMRR project as proposed will have No Effect on historic properties. This determination is based on the negative results of field investigation in the levee construction, bicycle trail construction, and wetland mitigation areas (Reaches 1 and 2) and on the minimal impact of closure construction within the CCHD, individual elements of that District determination, and archeological site 13PK61 (Reaches 3, 4, and 5).

Request for Information from Consulting Parties:

The Corps is seeking information from all consulting parties regarding their concerns with issues relating to this undertaking's potential effects on historic properties and, particularly, the tribes' concerns with identifying properties that may be of religious and cultural significance to them and may be eligible for the NRHP [36 CFR 800.4(a)(3-4)]. Concerns about confidentiality [36 CFR 800.11(c)] regarding locations of properties can be addressed under Section 304 of the National Historic Preservation Act which provides withholding from public disclosure the location of properties under several circumstances, including in cases where it would cause a significant invasion of privacy, impede the use of a traditional religious site by practitioners, endanger the site, etc.

The Corps has identified the consulting parties for this undertaking as set out in 36 CFR 800.2 and invites them by copy of this letter to participate in the Section 106 process (See Distribution List). We request your written comments on this project within 30 days, pursuant to 36 CFR 800.3(c)(4). Results of all consultation and determination shall be included in the Environmental Assessment for additional public review this year.

If you have any questions regarding this matter, please call Mr. Jim Ross of our Economic and Environmental Analysis Branch at 309/794-5540, or you may write to our address above, ATTN: Planning, Programs, and Project Management Division (Jim Ross)..

Sincerely,

ORIGINAL SIGNED BY
John P Carr

Kenneth A. Barr
Chief, Economic and Environmental
Analysis Branch

Enclosures

MFR: Letter requesting comments from the Consulting Parties regarding the subject PA.

CF (all wo/encls):
Dist File (PM-M)
PM-A (Ross, Clingerman)

DISTRIBUTION LIST

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Chairman
Yankton Sioux Tribal Business and Claims
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Deanne Bahr
NAGPRA Coordinator
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3.3 Iowa Department of Natural Resources Coordination

Fields of Opportunity

THOMAS J. VILSACK, GOVERNOR
SALLY J. PEDERSON, LT. GOVERNOR

STATE OF IOWA

DEPARTMENT OF NATURAL RESOURCES
JEFFREY R. VONK, DIRECTOR

March 10, 2004

Mr. Kenneth A. Barr
U.S. Army Corps of Engineers – Rock Island District
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

RE: Feasibility study area for various flood protection alternatives for the Birdland Park levee reach, the Central Place levee reach and the Downtown levee reach, letter dated February 12, 2004

Dear Mr. Barr:

Thank you for inviting our comments on the impact of the above referenced project on protected species and rare natural communities.

We have searched our records of the project area and found no site-specific records of rare species or significant natural communities that would be impacted by this project as long as there are no disturbances to the riverbed at or below the ordinary high water line of either the Des Moines River or the Raccoon River. However, our data are not the result of thorough field surveys. If listed species or rare communities are found during the planning or construction phases, additional studies and/or mitigation may be required. Any construction that would affect the riverbed at or below the high water line would require a sovereign lands construction permit from this Department.

This letter is a record of review for protected species, rare natural communities, state lands and waters in the project area, including review by personnel representing state parks, preserves, recreation areas, wetlands, fisheries and wildlife but does not include any potential comment from the Environmental Services Division of this Department. This letter does not constitute a permit and before proceeding with this project, permits may be needed from this Department or from other state or federal agencies.

Effective March 10, 2003, any construction activity that bares the soil of an area greater than or equal to 1 acre including clearing, grading or excavation may require a storm water discharge permit from the Department. Construction activities may include the temporary or permanent storage of dredge material. For more information regarding this matter, please contact Ruth Rosdail at 515/281-6782.

The Department administers regulations that pertain to fugitive dust IAW Iowa Administrative Code 567-23.3(2)"c". All persons shall take reasonable precautions to prevent the discharge of visible emissions of fugitive dusts beyond the lot line of property during construction, alteration, repairing or demolishing of buildings, bridges or other vertical structures or haul roads. All questions regarding fugitive dust regulations should be addressed to Jim McGraw at 515/242-5167.

If you have any questions about this letter or if you require further information, please contact me at (515) 281-8967.

Sincerely,

KEITH L. DOHRMANN, ENVIRONMENTAL SPECIALIST
POLICY AND COORDINATION SECTION
CONSERVATION AND RECREATION DIVISION

04-2576L

WALLACE STATE OFFICE BUILDING / 502 EAST 9th STREET / DES MOINES, IOWA 50319
515-281-5918 TDD 515-242-5967 FAX 515-281-6794 www.iowadnr.com

Fields of Opportunities

STATE OF IOWA

THOMAS J. VILSACK, GOVERNOR
SALLY J. PEDERSON, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
JEFFREY R. VONK, DIRECTOR

March 11, 2004

Mr. Kenneth A. Barr
U.S. Army Corps of Engineers – Rock Island District
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

RE: Feasibility study area for various flood protection alternatives for the Birdland Park levee reach, the Central Place levee reach and the Downtown levee reach, letter dated February 12, 2004

Dear Mr. Barr:

Thank you for inviting our comments on the impact of the above referenced project on wetlands and waters of the U.S.

The project will impact 1.3 acres of emergent, scrub-shrub, and forested wetland in the Des Moines River watershed but will be mitigated in the Skunk River watershed with 1.8 acres of forested wetland. The Iowa Department of Natural Resources would like the Corps of Engineers to investigate mitigation within the Des Moines River watershed or explain in the Environmental Assessment why it is not practicable as defined under the Clean Water Act, Section 404 (b)(1) guidelines. We'd also like the mitigation ratio increased in the event the (out-of-watershed) Franklin Township site (S11, T80W, R22W, Polk County) is used. The mitigation plan should take into consideration all three types of wetland being impacted (emergent, scrub-shrub, and forested) and provide as much in-kind mitigation as is possible. Please take into consideration the maturity and diversity of the forested wetland being impacted when designing the mitigation site.

Best management practices should be incorporated into the work plans to maintain the chemical, physical, and chemical integrity of the waters of the U.S.

If you have any questions about this letter or if you require further information, please contact me at (515) 281-6615.

Sincerely,

Christine M. Schwake

CHRISTINE M. SCHWAKE
WATER RESOURCES SECTION

WALLACE STATE OFFICE BUILDING / 502 EAST 9th STREET / DES MOINES, IOWA 50319
515-281-5918 TDD 515-242-5967 FAX 515-281-6794 www.iowadnr.com

3.4 Draft Fish and Wildlife Coordination Act

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Rock Island Field Office
4469 48th Avenue Court
Rock Island, Illinois 61201
Phone: (309) 793-5800 Fax: (309) 793-5804

IN REPLY REFER TO
FWS/RIFO

May 26, 2004

Colonel Duane P. Gapinski
District Engineer
U.S. Army Engineer District
Rock Island
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Gapinski:

This letter constitutes our draft Fish and Wildlife Coordination Act (FWCA) report for the City of Des Moines Flood Control Feasibility Study, Polk County, Iowa. It has been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat.401, as amended; 16 U.S.C. 661 et seq.); the Endangered Species Act of 1973, as amended; and in accordance with the Fish and Wildlife Service's Mitigation Policy.

This Feasibility Study, conducted under the authority of Section 216 of the 1970 Flood Control Act, involves developing a flood damage reduction plan for the project sponsor, the City of Des Moines, that includes structural modifications to an existing flood control project. Three specific locations or reaches have been identified for improvement in this study. They are referred to as Central Place, Birdland Park, and Downtown Des Moines. Each segment was evaluated individually with corresponding mitigation measures, if any, identified and quantified for each segment.

DESCRIPTION OF THE PROJECT AREA

The project is located at the confluence of the Raccoon River with the Des Moines River in the metropolitan area of the City of Des Moines, Iowa. Bordered by an existing levee system the floodplain ecosystem is defined by the limits of the levees in this highly urbanized setting. Habitats are typical of floodplain river systems with a mixture of bottomland forest, ox-bow and meander scar wetlands, and the aquatic open water community of the rivers themselves. Seasonal flooding during periods of spring rain and snowmelt runoff is common and for the most part, floodwaters are contained within the existing levee system. However, larger

magnitude flood events have occurred recently which have breached the levee system and caused extensive damage to residences and businesses in the Des Moines area. Situated within the commercial development and residential properties of the project is a small greenspace area owned by the local Kiwanis club. The park-like setting includes an oxbow wetland with deep enough water to support some fish surrounded by a relatively mature bottomland forest that is used by wintering bald eagles. It provides additional habitat diversity within the confines of the riparian corridor.

PROJECT OBJECTIVES

The objective of this study is to evaluate the integrity of the existing levee system and determine the need for upgrading and repair to ensure the current level of flood protection is maintained. Closure structures in the downtown area include a combination of sandbags and floodwalls and minor berm construction.

METHODOLOGY

An inter-agency team evaluated the project area and conducted a habitat analysis to quantify the impacts and develop appropriate mitigation measures to offset those impacts. The habitat analysis of existing study area conditions, future conditions without the project, and impacts of the several proposed alternatives and increments was accomplished using a modified version of the numerical habitat appraisal methodology the Expert Habitat Evaluation Technique (EXHEP), based on USFWS Habitat Evaluation Procedures (HEP). The analysis employed an inter-agency team approach with representatives from the Corps of Engineers, the Iowa Department of Natural Resources, and the U.S. Fish and Wildlife Service.

The EXHEP analysis is a numerical system for evaluating the quality and quantity of particular habitats for animal species selected by the EXHEP team members. The evaluation species used in this analysis are an established set in the EXHEP model. Although a set list of species has been used, each species represents a guild of other similar species that utilize the habitat in similar ways. Each species represents an array of habitat variables for the species being evaluated. These species represent key management goals and objectives of the project. The qualitative component of the analysis is known as the Habitat Suitability Index (HSI) and is rated on a 0.1 to 1.0 scale. The quantitative component of the EXHEP analysis is the measure of acres of habitat that are available for the selected evaluation species. From the qualitative and quantitative determinations, the standard unit of measure, the Habitat Unit (HU), is calculated using the formula (HSI x Acres = HUs).

Examples of wildlife species used to evaluate the different habitats and project features are as follows. Mallard and Canada goose are migratory waterfowl that utilize early-successional wetland habitat and have socioeconomic importance as game species. The green-backed heron is a wading bird found in mid-successional herbaceous and shrub dominated wetland habitat. American coot is a waterfowl species utilizing both open water and backwater areas. The least

bittern, muskrat, and king rail prefer emergent marsh habitat. The lesser yellowlegs utilizes shoreline, mudflat habitat. The beaver is a resident furbearing mammal that utilizes early-successional forest habitat. The wood duck is a waterfowl species that favors mature forested wetland habitat with abundant snags and cavity trees. The parula and prothonotary warblers are neotropical migrant songbirds that utilize mature forested wetland habitat during the breeding season.

Changes in the quality of the habitats and HUs for each species will occur as a habitat matures naturally or is influenced by development. These changes influence the cumulative HU derived over the life of the project. Cumulative HUs are annualized and averaged. This determines what is known as the Average Annual Habitat Units (AAHUs). AAHUs are used as an output measurement to compare all the features and the project as a whole.

To complete the habitat evaluation, the study team reviewed aerial photography, topographic maps, and preliminary design drawings. The study team based much of the existing condition information on prior sampling of the study areas. Assumptions were developed regarding existing conditions and project/post-project conditions relative to limiting factors and management practices.

For project planning and impact analysis, project life was established as 50 years. To facilitate comparison, target years were established at 0 (existing conditions) 1, 25, and 50 years. HSIs and AAHUs for each evaluation species were calculated to reflect expected habitat conditions over the life of the project.

Selected data will be presented in this report with reference to the habitat analysis. To avoid duplication of tables, we refer the reader to the Environmental Appendix (Appendix G) in the main body of the Feasibility Project Report for the complete tabular results of HSI and AAHU values for each of the project features.

THREATENED AND ENDANGERED SPECIES

To facilitate compliance with Section 7C of the Endangered Species Act of 1973, as amended, Federal agencies are required to obtain from the Fish and Wildlife Service information concerning any species, listed or proposed to be listed, which may be present in the area of a proposed action.

Therefore, we are furnishing you the following list of species which may be present in the concerned area:

Classification	Common Name	Scientific Name	Habitat
Threatened	Bald eagle	*Haliaeetus leucocephalus*	Winters along major rivers and reservoirs

Threatened	Western prairie fringed orchid	*Platanthera praeclara*	wet prairies
Endangered	Indiana bat	*Myotis sodalis*	Caves, mines (hibernacula); small stream corridors with well developed riparian woods; upland forests (foraging)
Threatened	Prairie bush clover	*Lespedeza leptostachya*	dry gravelly prairie soils

Bald eagles breed and winter along the Des Moines River. Suitable perch trees where eagles can loaf and perch are numerous. During the winter, this species feeds on fish in the open water areas created by dam tailwaters, the warm water effluents of power plants and municipal and industrial discharges, or in power plant cooling ponds. The more severe the winter, the greater the ice coverage and the more concentrated the eagles become. They roost at night in groups in large trees adjacent to the river in areas that are protected from the harsh winter elements. They perch in large shoreline trees to rest or feed on fish. There is no critical habitat designated for this species. The eagle may not be harassed, harmed, or disturbed when present nor may nest trees be cleared.

The western prairie fringed orchid is considered to potentially occur statewide based on historical records and habitat distribution. It occupies wet grassland habitats. There is no critical habitat designated for this species. Federal regulations prohibit any commercial activity involving this species or the destruction, malicious damage or removal of this species from Federal land or any other lands in knowing violation of state law or regulation, including state criminal trespass law. This species should be searched for whenever wet prairie remnants are encountered.

The endangered Indiana bat has been noted as occurring in several Iowa counties in Iowa. **It could potentially occur in all counties south of Interstate 80, including those portions of Dallas, Polk, Jasper, Johnson, Muscatine and Scott Counties south of Interstate 80.**

Indiana bats migrate seasonally between winter hibernacula and summer roosting habitats. Winter hibernacula include caves and abandoned mines. Females form nursery colonies under the loose bark of trees (dead or alive) and/or cavities, where each female gives birth to a single young in June or early July. A single colony may utilize a number of roost trees during the summer, typically a primary roost tree and several alternates. The species or size of tree does not appear to influence whether Indiana bats utilize a tree for roosting provided the appropriate bark structure is present.

During the summer, the Indiana bat frequents the corridors of small streams with riparian woods as well as mature upland forests. It forages for insects along stream corridors, within the canopy of floodplain and upland forests, over clearings with early successional vegetation (old fields), along the borders of croplands, along wooded fencerows, over farm ponds and in pastures.

Suitable summer habitat in Iowa is considered to have the following characteristics within a ½ mile radius of a project site:

1) forest cover of 15% or greater;
2) permanent water;
3) one or more of the following tree species: shagbark and shellbark hickory that may be dead or alive, and dead bitternut hickory, American elm, slippery elm, eastern cottonwood, silver maple, white oak, red oak, post oak, and shingle oak with slabs or plates of loose bark;
4) potential roost trees with 10% or more peeling or loose bark

If the project site contains **any habitat that fits the above description**, it may be necessary to conduct a survey to determine whether the bat is present. In addition, a search for this species should be made prior to any cave-impacting activities. If habitat is present or Indiana bats are known to be present, they must not be harmed, harassed, or disturbed when present, and this field office should be contacted for further assistance.

Prairie bush clover is listed as threatened is considered to potentially occur statewide in Iowa based on historical habitat. It occupies dry to mesic prairies with gravelly soil. There is no critical habitat designated for this species. Federal regulations prohibit any commercial activity involving this species or the destruction, malicious damage, or removal of this species from Federal land or any other lands in knowing violation of state law or regulation, including state criminal trespass law. This species should be searched for whenever prairie remnants are encountered.

Prior to construction, the Corps of Engineers will need to determine the effect, if any, on the above listed species. A **no effect** determination will preclude the need for further consultation on a species unless the project is modified or new information indicates endangered species may be affected. Any determination other than no-effect will require additional coordination with the Service as required by Section 7 of the Endangered Species Act of 1973, as amended.

EXISTING FISH AND WILDLIFE RESOURCES

The project area provides habitat for a variety of wildlife including waterfowl and wading birds. Mallards and Canada geese nest in the project area along with many nongame and neotropical migrant bird species like catbirds (*Dumetella carolinensis)* and warblers. Dominant

tree species include silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*), cottonwood (*Populus deltoides*), box elder (*Acer negundo*), elm (*Ulmus americana*), and willow (*Salix* sp.). Understory tree species include willow, silver maple, green ash, box elder, mulberry (*Morus* sp.), hackberry (*Celtis occidentalis*), and false indigo (*Amorpha fruticosa*). Herbaceous species include *Leersia* sp., *Scirpus* sp., cattails (Typha sp.), sedges (*Carex* sp.), and a predominance of reed canary grass (*Phalaris arundinacea*).

Typical of bottomland forest communities, the resident mammals include white-tailed deer (*Odocoileus virginianus)*, raccoon (*Procyon lotor*), opossum (*Didelphis marsupialis*), mink (*Mustela vison*), muskrat (*Ondatra zibethicus*), and river otter (*Lutra canadensis*). The river fishery is consistent with other interior Iowa fish populations comprised of carp (*Cyprinus carpio*), longnose gar (*Lepisosteus osseus*), gizzard shad (*Dorosoma cepedianum*), mooneye (*Hiodon tergisus*), black crappie (*Pomoxis nigromaculatus*), northern pike (*Esox lucius*), walleye (*Stizostedion vitreum*), sauger (*Stizostedion canadense*), channel catfish (*Ictalurus punctatus*), and white bass (*Morone chrysops*).

The study team agreed to utilize species that were representative of those found in an urbanized riparian setting and that would be directly affected by the implementation of the project features. Evaluation of the proposed array of alternatives concluded with the selection of the parula warbler (*Parula americana*) as a species representative of the bottomland forest complex comprised of large mature silver maples and cottonwoods; and the fox squirrel (*Sciurus niger*) as the species most representative of forested upland habitat and highly urbanized environs. Both of these species' habitat guilds will be affected by the upgrading of the levee reaches and would benefit from mitigation plans to compensate for those impacts.

DISCUSSION OF PROJECT FEATURES

Project features as proposed have been defined by the affected reaches of levee: approximately 6000 feet of levee upgrade along Birdland Park, 1.1 miles of levee upgrade along the Central Place reach, and several closing structures (i.e. sandbags, floodwalls, etc.) in the downtown Des Moines area proper. Levee upgrades consist of removing existing vegetation along the alignment, and restoring the cross-sectional area and integrity of the fill material to Corps of Engineers standards and specifications. Minor new levee and berm construction is necessary to effectively tie-off the existing levees into higher ground. Along with construction of the levee proper, additional construction features such as seepage berms and cutoff trenches may be necessary to complete the upgrade. Once the construction is complete, the levees will be seeded to grass cover and mowed and maintained as required by the Corps of Engineers.

FUTURE WITHOUT PROJECT

The No Federal Action alternative is considered the future without the project condition allowing the area to continue to function as is. Without active management or repairs and upgrades to the levee system, the affected area will continue to flood seasonally. Flood

damages in the downtown Des Moines area will continue with larger magnitude flood events. As successional changes in habitat evolve over time, the structural integrity of the levee system becomes questionable as trees grow larger on the levee, threatening damage both from roots growing into the levee posing a seepage risk and trees toppling over and pulling out large root wads from the embankment.

Since the project area is highly developed, not much new encroachment into the remaining habitats is likely. Therefore, the bottomland forest community will continue to exist relatively unchanged. This habitat value has been quantified using the EXHEP model and the two indicator species: the parula warbler and the fox squirrel. The parula warbler represents the species typically found in larger more mature bottomland forest communities. The size class of the trees is critical to the relative value of the habitat for the species. Under the without project alternative, the trees will continue to grow and mature along with the successional progression of the understory growth into a more mature bottomland forest. The study team determined that HSI value for the parula warbler would remain high under this alternative over the 50-year project life. The resulting AAHU value of 1.40 is the numerical habitat value that must be exceeded under the with-project condition to ensure that there is no loss of habitat value for the bottomland species represented by the parula warbler guild. Similar results have been tabulated for the fox squirrel, the species selected by the study team to represent the upland/urban forested habitat type that occurs in the project area. An AAHU value of 2.90 over the 50-year project life has been tabulated as the minimum value for any with project alternative.

FUTURE WITH PROJECT

As discussed earlier in this report, the implementation of the proposed project includes a combination of levee improvements, installation of a series of closure structures and temporary flood control measures (i.e. sandbags), and construction of new levee reaches or tie-off berms. The total acreage of affected habitats appears small when quantifying it for the purposes of analysis (less than 10 acres for all habitats). However, the net result is further fragmentation of the remaining riparian corridor since that acreage is spread over an alignment several miles long, and encompasses a large tract of Des Moines River bottomland forest and wetland complexes. The relative impact will be confined to the levee structure proper and associated levee toe (approximately 15 feet out from the base of the levee). The one exception is the construction of a new levee reach through the Birdland Park area that will affect forest, wetland, and open water habitats, as well as the aesthetic aspects of the park. The trees cleared from the levee alignment will result in a permanent habitat loss for those species using those habitats. Several of the park trees near the alignment are large mature trees that are used by wintering eagles and their removal should be avoided if possible. The newly upgraded levees will be maintained by mowing to keep trees and shrubs from reestablishing.

The direct impacts associated with the levee improvements such as clearing trees, filling wetlands, and minor habitat alterations have been quantified and compensated for in a

comprehensive mitigation plan that has been developed by the study team with input from the natural resource agencies. For the purpose of evaluation, the study area was categorized according to the following habitat types: wetland, aquatic, and upland. These habitat types were further subdivided into the following categories: bottomland forested wetland and nonforested wetland.

Table 1. Existing habitat types and acreages that would be affected by the project.

Wetland habitat type	Acres: Birdland	Central Place
Bottomland forest	1.4	1.2
Non-forested wetland	0.1	
Open water (hemi-marsh)	1.8	
Upland habitat type	**Acres: Birdland**	**Central Place**
Upland hardwoods	1.4	3.2

To the extent possible, mitigation for the impacts of clearing and filling has been designed to occur within the project reach. However, the City of Des Moines owns an 85 acre off-site mitigation area (Euclid Mitigation Area) located within the larger 7000 acre Chichaqua greenbelt owned by the Polk County Conservation Board. The deficit in mitigation acreage will be replaced at the off-site Euclid Mitigation Area. In order to determine a quantifiable acreage of mitigation that would adequately off set the impacts of clearing several miles of large trees and understory vegetation, qualitative and temporal factors are included in the calculations. In other words, planting balled and burlap trees in place of 60-foot tall trees will have a lag period before those smaller trees are of the same habitat value as the existing trees. To compensate for the lag, a larger acreage than is impacted is planted with higher quality trees (i.e. mast producing species). The ratio varies but using the EXHEP model, the AAHU values for the with-project condition are 1.69 and 5.42 for the parula warbler and fox squirrel, respectively. A net positive AAHU value results for both species using a combination of on-site and off-site mitigation.

The hemi-marsh impacts resulting from the proposed construction of the new levee alignment through the Birdland Park Kiwanis Park will require a mitigation design that includes a 50:50 ratio of emergent wetland to open water component. Currently, the marsh has a well established area of cattails in part of the oxbow, as well as, a large open water area adjacent to it. The proposed levee alignment will bisect and fill a large part of both components of the marsh and therefore, will need to be mitigated as a unit with a 2:1 ratio to offset delay in establishing a new hemi-marsh complex.

DISCUSSION

The implementation of the proposed project as discussed will result in a reduction in damage to businesses, residences, and properties by floodwaters. Impacts to the various habitats will be compensated for either on-site along the project area or in the Euclid Mitigation Area of the Chichaqua greenbelt. These impacts have been minimized by the rehabilitation of an existing levee system and consideration of nonstructural alternatives in the downtown area. Using the EXHEP methodology and the selection of representative target species, the study team was able to adequately address these impacts and formulate a compensatory mitigation plan. The loss of existing large trees along the levees and levee toe is reflected in the habitat values of the parula warbler declining under the with project condition. Future maintenance of the area in mowed grass is of no value to the species represented by the parula warbler. Mitigation with balled and burlapped mast producing trees will in time offset the near term habitat losses. This is reflected in the habitat values of the fox squirrel increasing over the 50-year project life. The net annualized result is positive though a portion of the value is proposed for off-site mitigation.

Another important aspect of the mitigation is compensating for the loss of hemi-marsh wetland at Birdland Park. Ideally, a less intrusive structure would minimize impacts to the marsh, be more aesthetically appealing, and not require such a large acreage of the park. However, any impacts to the marsh will require adequate compensation at the Euclid Mitigation site in the form of a hemi-marsh habitat at a 2:1 ratio.

Completion of the project will also have indirect impacts in the form of increased downstream flooding impacts. Loss of flood storage areas continues to occur as more and more levees are raised or improved and the rate at which runoff reaches the river system is increased as a result of paving landscapes in urban areas and tiling of agricultural fields in rural areas. Although beyond the scope of this project, it is worthy of noting that downstream landowners will bear the effects of improved flood control on the upstream reaches of the river system. The Corps of Engineers should investigate these indirect impacts and incorporate them into a comprehensive plan for mitigating the effects to downstream landowners and businesses in the future.

CONCLUSIONS AND RECOMMENDATIONS

The continued threat of serious flood damages to the City of Des Moines and potential catastrophic breach of the existing levee system has warranted the need to evaluate and implement improvements to ensure the safety of the Des Moines business and residential community. Environmental impacts associated with this level of protection have been quantified to the extent possible and mitigated in a proposed off-site mitigation area as well as on-site where feasible. Factors such as temporal lag before tree plantings mature were considered and compensated for by the use of higher quality mast trees and increasing the acreage of the mitigation plantings.

Therefore we have no objection to selection of the preferred alternative which includes:

1. Improvements to the existing Birdland Park and Central Park levee systems as earlier discussed. The existing levee will be cleared of trees and shrubs and brought up to Corps of Engineers specifications. The levees will subsequently mowed and maintained.

2. Installation and construction of the floodwall, sandbag, and closure elements necessary in the downtown area of Des Moines.

3. Implementation of the comprehensive mitigation plan, on-site where feasible, and at the Euclid Mitigation Area, including post project monitoring and replacement of plantings when necessary to ensure success of the mitigation effort.

We appreciate the opportunity to provide these comments and look forward to continued coordination on this project. If you have any questions, please contact Mr. Joe Slater of my staff at (309) 793-5800, ext. 208.

Sincerely,

Richard C. Nelson
Supervisor

cc: IADNR (Joens)

S:\Office Users\Joe\DesMoines 216.doc

3.5 Natural Resource Conservation Service Coordination

CONVERSATION RECORD

TIME: 1400 DATE: 4/7/04

TYPE: ☐ VISIT ☐ CONFERENCE ☒ TELEPHONE ☐ INCOMING ☒ OUTGOING

ROUTING: NAME/SYMBOL | INT

Location of Visit/Conference:

NAME OF PERSON(S) CONTACTED OR IN CONTACT WITH YOU: Richard Bednarek

ORGANIZATION (office, dept., address): NRCS, Atlantic Off.

TELEPHONE NO: 712-243-1576

SUBJECT: Farmland Conversion Impact Rating

SUMMARY

I called Richard Bednarck, NRCS Soil Scientist, to ask if the Rock Island District needs to fill out a Farmland Conversion Impact Rating for one of the compensatory mitigation sites for the Des Moines 216 project. An agricultural field in Polk County will be converted to an upland forest and a wetland in order to compensate for project impacts. Mr. Bednarck stated that he does not believe that we need to fill out the form since we aren't doing anything that would prevent agriculture from occurring on the site in the future. He will check on that and said that if I don't hear from him by Monday, April 12, I can assume that the District does not need to fill out the form.

ACTION REQUIRED

Document conversation and fill out form only if Mr. Bednarck calls to say that it's necessary.

NAME OF PERSON RECORDING CONVERSATION (Typed or printed): [illegible]

SIGNATURE: [illegible]

DATE: [illegible]

ACTION TAKEN

SIGNATURE | TITLE | DATE

CONVERSATION RECORD

OPTIONAL FORM 271 (12-76)
DEPARTMENT OF DEFENSE

3.6 Public Review Request for Integrated Environmental Assessment

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT CORPS OF ENGINEERS
CLOCK TOWER BUILDING - P O BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

June 16, 2005

Planning, Programs, and
Project Management Division

SEE REPORT DISTRIBUTION LIST

The Rock Island District of the U.S. Army Corps of Engineers has enclosed, for your review, a CD that contains the Draft Feasibility Report with Integrated Environmental Assessment (EA), and a draft Finding of No Significant Impact (FONSI), addressing a flood damage reduction project for the Des Moines and Raccoon Rivers in Des Moines, Iowa. This feasibility report and EA identifies alternatives for levee upgrades and closure structures, and evaluates the impacts associated with each alternative. The report with integrated EA is also available for viewing and downloading on the study's website at http://www.mvr.usace.army.mil/DesMoinesFP/Documents/Feasibility200505/.

The EA is being circulated for a 30-day public review period, commencing from the date of this letter. If at the end of the 30 days, no comments are received that alter the determination that no significant environmental impacts will result, the FONSI will be signed and kept on file at the Rock Island District office.

Questions concerning the EA and FONSI, or requests to be sent a hard copy of the report, may be addressed to Ms. Gail Clingerman, Economic and Environmental Analysis Branch, Planning, Programs, and Project Management Division, telephone 309/794-5791. Written comments may be sent to our address above, ATTN: Planning, Programs, and Project Management Division (Gail Clingerman).

Sincerely,

Donald A. Ballman

for: Kenneth A. Barr
Chief, Economic and
Environmental Analysis Branch

Enclosure

3.7 Iowa State Historic Preservation Office Coordination

STATE HISTORICAL SOCIETY of IOWA

A Division of the Iowa Department of Cultural Affairs

August 9, 2004

In reply refer to:
R&C#: 000377008

Mr. Jim Ross, Archaeologist
Economic and Environmental Analysis Branch
Corps of Engineers – Rock Island District
Clock Tower Building P.O. Box 2004
Rock Island, IL 61204-2004

RE COE – POLK COUNTY – CITY OF DES MOINES – DES MOINES AND RACCOON RIVERS FEASIBILITY STUDY – SEC. 216 FLOOD CONTROL PROJECT & WETLAND MITIGATION – CORPS DETERMINATION

Dear Mr. Ross,

By this letter, the Iowa State Historic Preservation Office (henceforth SHPO) accepts the Corp's (Rock Island District) invitation to consult on this undertaking. Our comments and recommendations are presented below in the order of their occurrence within the letter dated July 21, 2004 under the heading SEE DISTRIBUTION LIST.

Federal Undertaking

1. The SHPO agrees that the proposed action constitutes a Federal undertaking eliciting review under section 106 of the National Historic Preservation Act of 1966 and its implementing regulations, 36 CFR part 800.

Area of Potential Effects (APE)

2. The SHPO agrees to comment on and contribute to identification efforts including definition of the project APE as per 36 CFR 800.4(a-b) and stipulates that the APEs defined for the various activities proposed by this undertaking must be defined in three-dimensional terms. We agree with the Corps' definition of the Area of Potential Effects for this undertaking as it is presently defined in the supporting documentation.

Consulting Parties

3. At this time, the SHPO knows of no other party with a demonstrated interest in historic properties that may be affected by this undertaking. However, if others do come forward during the review process, the SHPO encourages the Corp to consider their interests and invite their consultation when deemed appropriate per 36 CFR part 800.3(f).

State Historic Preservation Officer Invitation

4. In accordance with section 101 (b) (3) the SHPO agrees to assist the Corp in carrying out their section 106 responsibilities for this undertaking.

5 In doing so, the SHPO will act in the best interests of the State of Iowa and its citizens in the preservation of their cultural heritage as mandated by 36 CFR 800.2 (c) (1).

Identification of Historic Properties (Agency Evaluation of Historic Significance, etc.)

6 Based on background research the Corps has determined that the APE contains portions of archaeological site 13PK61, which consists of components relating to prehistoric Woodland and Oneota occupations, Fort Des Moines #2, and the early settlement of the City of Fort Des Moines. 13PK61 has been determined as eligible for listing in

600 EAST LOCUST STREET, DES MOINES, IA 50319-0290 P: (515) 281-5111

the National Register of Historic Places by previous undertakings which have occurred within its boundaries. Portions of the APE also coincide with the Civic Center Historic District and may effect some of its constituent elements.

7. The Corps has determined that the proposed 216 Flood Control project will not effect historic properties. These findings are summarized by item in Exhibit 6. We are able to concur with the Corps' determination of 'no effect' for the following (ID#): Reach 3: 1, 2, 10, and 12; Reach 4: 13, and 14; Reach 5: 23 and 24 provided that all excavation is confined to areas of past disturbance.

8. The SHPO is unable to concur with the Corps' determination of 'no effect', but would be able to concur with a determination of 'no adverse effect' for the following (ID#): Reach 3: 3, 4, 5, 6, 7, 8, 9, and 11; Reach 4: 16, 17, 18, 19, 20, 21, and 22 provided that all excavation is confined to areas of past disturbance.

Thank you for inviting our consultation on this undertaking. Please forward your revised determination to us if you are in agreement so that we can issue our concurrence. In the meantime f you have any questions, or if I can be of further assistance please feel free to contact me at (515) 281-8744.

Sincerely,

Daniel K. Higginbottom, Archaeologist
Iowa State Historic Preservation Office

3.8 Iowa DNR Letter Clearing HTRW Concerns

Fields of Opportunities

STATE OF IOWA

THOMAS J. VILSACK, GOVERNOR
SALLY J. PEDERSON, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
JEFFREY R. VONK, DIRECTOR

February 7, 2005

Dave McGuffin
City Hall
400 East 1st street
Des Moines, IA 50309-4112

RE: Levee Phase II ESA

Dear Mr. McGuffin:

The Iowa Department of Natural Resources has reviewed the following reports submitted under the levee project for flood damage reduction for the Des Moines and Raccoon Rivers in Des Moines, Iowa. The levees are described as follows:

Birdland Park Levee
Central Place Levee
Downtown East Levee
Downtown West Levee
Harriet Street Landfill Levee

The reviews concentrated on the levees and not on adjacent properties that might impact the levees. Our review showed that soil samples from the levee sites showed slightly elevated heavy metal and benzo(a)pyrene levels in soil. The heavy metal levels generally were within background levels that would be found in Iowa. There was little groundwater and this tended to indicate minimal contaminant levels.

Based on the information provided the department is of the view that these sites present minimal threat to human health and the environment and, therefore, no further investigation is required. The department reserves the right to require additional investigation if future information warrants such action.

If you have any questions, please contact me at 515-281-4117.

Sincerely,

Lambert A. Nnadi
Environmental Specialist Snr., Contaminated Sites Section

WALLACE STATE OFFICE BUILDING / 502 EAST 9th STREET / DES MOINES, IOWA 50319
515-281-5918 TDD 515-242-5967 FAX 515-281-6794 www.iowadnr.com

3.9 Otoe Missouria Tribal Coordination

Otoe-Missouria Tribe
8151 Highway 177, Red Rock, Oklahoma 74651-03048

(580) 723-4466 Tribal Operations
(580) 723-4540 Law Enforcement Office
(580) 763-1556 Mobile Police Unit
(580) 268-3016 Head Start Program
(580) 268-3101 Social Service
FAX (580) 723-4273

August 26,2004

Department of the Army
Rock Island District Corps of Engineers
Clock Tower Bldg. P,O.Box 2004
Rock Island, Illinois 61204-2004

Attn: Planning, Programs, and Project Management

Dear Mr. Ross:

Per your request for a written response in regard to the Des Moines and Racoon Rivers (DMRR) project:

The Otoe-Missouria Tribe and its ancestors , the Oneota , once occupied large areas of Illinois, Missouri, Iowa and Nebraska. However, we do not have any specific information that indicates your project site would be of any concern to the Otoe-Missouria Tribe.

If you should, during your project discover remains and/or cultural items, especially at the one previously recorded archeological site, we would appreciate your notification.

Sincerely

Mildred Hudson

Mildred Hudson
NAGPRA Director

Section 4 Summary.

The techniques selected in the public involvement plan – newsletters, website and open house – in conjunction with the initial coordination letter, allowed for coordination with the public throughout the study. In addition, the District study team coordinated extensively with the City study team. The recommended plan for the Des Moines and Raccoon Rivers, Des Moines, Iowa, Feasibility Study was influenced by the public involvement process.

US Army Corps of Engineers
Rock Island District

DES MOINES AND RACCOON RIVERS FEASIBILITY STUDY NEWSLETTER
FEBRUARY 2000

CORPS OF ENGINEERS AND CITY OF DES MOINES ENTER INTO PARTNERSHIP TO IDENTIFY FLOOD DAMAGE REDUCTION OPPORTUNITIES

On September 13, 1999, the Rock Island District of the U.S. Army Corps of Engineers and the City of Des Moines entered into a partnership agreement to identify opportunities for flood damage reduction within the City. This partnership approach is a new initiative by the Corps of Engineers to improve cooperation with local governments affected by flooding and is the result of a long history of the Corps and the City working to reduce flooding in Des Moines. The focus of the partnership will be the Des Moines and Raccoon Rivers and the major tributaries.

Prior to the partnership being established, the Corps undertook a reconnaissance study to determine if there was adequate justification to proceed with a partnership. This reconnaissance study focused on historical incidences of flooding in Des Moines, including the events of 1993. The results of the reconnaissance study indicated adequate justification for further investigation. This investigation will take nearly four years to complete and will result in a feasibility report with recommendations on improvements to the flood protection system in the City. This feasibility report will include computerized analyses of the rivers that will model how various levels of flooding impact the City. The report will evaluate economic impacts from flooding and examine improvements that can be made to the flood protection system. In addition, the environmental impacts of proposed improvements will be evaluated in accordance with the National Environmental Policy Act (NEPA).

The United States Congress has given the U.S. Army Corps of Engineers authority to assist the City of Des Moines with development of flood damage reduction projects. Over the years, the flood control system along the rivers has developed through a series of City and Federal projects that provide varying levels of protection. One of the goals of the feasibility study will be to identify projects that will qualify for Federal funding to bring the flood protection system up to a consistent standard of protection.

This investigation will be completed in phases, with the initial phase being the completion of the detailed hydrologic (rainfall and related runoff) and hydraulic (the way the water flows in the river) modeling. To support this effort, the City has been surveying cross sections of the river. The cross-section areas will be used in computer models that calculate water levels along the river. The results of these models will be used to evaluate alternative improvements and their ability to provide improved flood protection. Future phases will include development and evaluation of flood damage reduction alternatives at specific locations throughout the City. Alternatives will be evaluated based on their engineering, economic, environmental, cultural, and social feasibility.

The study team is comprised of representatives from the Rock Island District, Corps of Engineers, and from the City of Des Moines. Study disciplines include planning, engineering, geotechnical, hydrology, hydraulics, economics, survey, real estate, environmental/cultural, social analysis, and public involvement.

AREAS OF STUDY

During the reconnaissance study, the Corps of Engineers and the City identified seven areas warranting further review. During the feasibility study, the Corps of Engineers and City of Des Moines study team will be gathering data to allow for analyses of each of the areas.

Des Moines River Levee Between Southeast 6th Street and Southeast 14th Street – The Southeast 6th to Southeast 14th Streets area along the north and east side of the Des Moines River, immediately southeast of the downtown area, is protected by a flood levee. The levee protecting this 0.5-mile stretch of the northern left floodplain was constructed by the City, and was incorporated into the federal levee system constructed in the late 1960s (the Des Moines Local Flood Protection Project Stage I). During the 1993 flood, this section of levee experienced severe erosion. Since that time, modifications have been made to help improve the reliability of the levee. However, this stretch of levee continues to erode even after the rehabilitation attempts. Additional levee protection measures will likely be required to continue to protect the affected 200 acres of commercial, residential, and public facilities from flooding. This area includes a portion of the east Des Moines Downtown Business District and the Des Moines Department of Public Works facilities complex.

Des Moines River levee between SE 6th and SE 14th Streets

Birdland Park Levee – The Birdland Park area contains 170 acres of residential and commercial property. This area includes the North High School complex and Birdland City Park, in addition to numerous commercial establishments. The area is mapped in the National Flood Insurance Program as having 100-year flood protection by an existing levee constructed by the City in the 1890s. This levee was overtopped during the 1993 flood, causing extensive flood damages. This levee requires upgrading to meet current Corps of Engineers flood protection levee standards. A comprehensive analysis of the levee height and structure will be conducted, along with street closures and other related structures.

Central Place Levee – The Central Place Business District is on the near north side of the City. This area was redeveloped as a commercial area in the 1970s and 1980s, and now is home to numerous commercial properties. The area is protected from flooding by a levee constructed by the City of Des Moines and is mapped in the National Flood Insurance Program as having 100-year flood protection. The levee was overtopped during the 1993 flood, causing extensive flood damages. Following the 1993 flood, the City undertook several measures to improve the level of protection provided by the levee (shown below); however, the levee still requires upgrading to meet the current Corps of Engineers flood protection standards.

Portion of Central Place Levee

The Central Place area is unique since it is lower than the normal river levels and, therefore, all runoff from the area must be pumped. The interior areas are presently serviced by four (4) large stormwater pump stations, which were constructed by the City.

Four Mile Creek – Prior to the era of regulated flood plain development, areas of Four Mile Creek from Des Moines' north city limits southerly to the creek's confluence with the Des Moines River on the east side of Des Moines were developed. The most intensive area of development is from East Aurora Avenue downstream to East University Avenue. This development has occurred on both sides of the creek. The Four Mile Creek 100-year floodplain contains approximately 270 structures including residences,

mobile homes, and a few businesses. The area has experienced frequent flash flooding, with flood damages occurring on at least twelve occasions since 1947. The most recent flooding occurred in 1998. The flash flooding nature of Four Mile Creek means there is very little response time to flooding events. In order to increase the actual warning time for these natural disasters, the City has installed a flood-warning system to allow adequate time to evacuate people from the flood area. However, the flashy nature of the stream does not allow adequate response time to protect property and properties have been repeatedly damaged by flooding over the years. In some cases, it is impractical to protect these structures from flooding; therefore, removal of the structures from the floodplain is the only alternative. The City has undertaken an effort, in cooperation with the Federal Emergency Management Agency (FEMA), to relocate residents and remove some flood-prone structures from the floodplain in the Williams Street area.

This partnership feasibility study will evaluate various alternatives that will minimize property damage during these flash floods.

Walnut Creek at Grand Avenue – Walnut Creek flows through an 84-square-mile watershed located west of the City in the western suburbs and Dallas County. The creek has experienced flash flooding on numerous occasions, including 1973, 1986, 1990, 1993, 1997, and 1998. The recently completed Corps of Engineers' West Des Moines – Des Moines Local Flood Protection Project provides comprehensive flood protection to the developed western right bank floodplain areas near the creek's confluence with the Raccoon River. The study area of concern is the unprotected developed floodplain area located on the east bank of the creek in the vicinity of Grand Avenue in the City. The 100-year floodplain in this area from 64th and Center Streets downstream to North Valley Drive contains several residences and businesses.

Downtown Levee System – The system of levees protecting the downtown area from flooding by the Des Moines and Raccoon Rivers is part of the federally constructed Des Moines Local Flood Protection Project completed in 1971. The levee system contains three major reaches of levee protecting both the right and left banks of the Des Moines and Raccoon Rivers and the area between the confluence of the two rivers. The protected areas contain over 1,800 acres of highly urbanized commercial, retail, industrial, residential, and public facilities at the central business core of the City.

The existing levee system was designed to provide 100-year flood protection. This system, designed in the 1960s, has numerous street and sewer closures that penetrate the line-of-protection at the design flood level. This situation causes the City to take multiple operational actions during a flood event. These actions include sandbagging, installing earthen closures, and placing and operating portable pumps. However, as demonstrated during the 1993 flood, floodwaters on both the Des Moines and Raccoon Rivers can rise rapidly, making the successful execution of these operations difficult. The feasibility study will look at weaknesses in the operation of the levee system and evaluate improvements that can be made.

This levee system is one of three that protects the downtown Des Moines area from the Des Moines and Raccoon Rivers flooding.

7th Ward Ditch South of University Avenue – The 7th Ward Ditch is a nine-square-mile drainage area on the near east side of Des Moines. Since the 1980s, the City has constructed several storm water detention basins and channel enhancements to improve the drainage and flood characteristics of the upper drainage area upstream of Easton Boulevard. Downstream of Easton Boulevard, the 7th Ward Ditch is a combination of underground storm sewer and overland corridor for approximately two miles - including the western edge of the Iowa State Fairgrounds. The underground storm sewer exits to an open ditch near East 30th Street and Dean Avenue. The City is currently in the process of constructing improvements to this underground sewer. Low-lying developed properties in this area and downstream towards the confluence with Four Mile

Creek frequently experience poor drainage and backwater flooding from Four Mile Creek. The feasibility study will evaluate steps that can be taken to improve both the storm sewer outlet and flood protection from the influence of Four Mile Creek.

CITY UTILIZES STATE-OF-THE-ART SURVEY TECHNIQUES TO PROVIDE DATA FOR FLOOD STUDY

The City of Des Moines, in partnership with the Corps of Engineers, is utilizing state-of-the-art satellite-based survey equipment to provide information for the flood protection system analyses. This equipment – known as Global Positioning System, or GPS – utilizes the same technology the military uses to locate objects. City surveyors will be performing surveys along the selected rivers and streams using GPS equipment, including using a boat to survey the river bottom.

For many years, surveyors relied on manual equipment to provide survey information that determined the location of objects and the topography. More recently, equipment utilizing radio waves was used to determine the distance between objects. Today's GPS equipment uses a worldwide satellite constellation to establish the location and elevation of a particular point with signals transmitted by the satellites to the ground equipment. The information is then used by a computer, where it can be utilized for the analysis. This process provides several advantages to the City. The equipment allows the survey data to be collected with a minimum of property disruption and is also a big labor and time saver, as it allows much of the data collection to be done by one person.

WHAT'S NEXT

The study team is now in the process of performing surveys of the rivers and streams necessary for determining updated flood levels. This information will be used to evaluate the costs and potential benefits of various alternatives to reduce flood damages. The surveys are anticipated to be complete in the spring of 2000.

PUBLIC INVOLVEMENT COMMENTS/QUESTIONS

The public will be kept informed and will have the opportunity to be involved throughout the study. This newsletter is a major part of this effort. Currently, four study newsletters are scheduled. A public meeting/workshop will be held at the study's mid-point and again at the study's conclusion. Additionally, the Rock Island District, Corps of Engineers, plans to develop a web page on the Internet that will provide Des Moines and Raccoon Rivers Feasibility Study information; e.g., newsletters, study map, and other pertinent data. For information about the Rock Island District and other Corps of Engineers offices, visit their web site at http://www.mvr.usace.army.mil/. The Des Moines and Raccoon Rivers Feasibility Study web page will be located at this site.

We welcome your input. If you have comments and/or questions regarding this study, please contact Mr. Dennis Hamilton, Project Manager, by telephone at 309/794-5634, fax at 309/794-5710, or e-mail at dennis.w.hamilton@usace.army.mil. If you prefer, you may write to Mr. Hamilton at the following address:

District Engineer
U.S. Army Engineer District, Rock Island
ATTN: CEMVR-PM-M (Hamilton)
Clock Tower Building - P.O. Box 2004
Rock Island, Illinois 61204-2004

The contact for the City of Des Moines is Mr. Scott Ralston. Mr. Ralston may be reached at:

City of Des Moines Engineering – Armory Building
602 East First Street
Des Moines, Iowa 50309
515/283-4954
E-mail: SARalston@ci.des-moines.ia.us

If you are aware of someone who may wish be added to the study's mailing list to receive this newsletter and future study mailings, please ask him/her to contact Mr. Ralston or Ms. Sue Simmons, Rock Island District, Corps of Engineers. Ms. Simmons may be contacted at the Rock Island District address listed above, by telephone at 309/794-5573, or by e-mail at suzanne.r.simmons@usace.army.mil.

US Army Corps of Engineers
Rock Island District

DES MOINES AND RACCOON RIVERS FEASIBILITY STUDY NEWSLETTER

CITY OF DES MOINES

January 2002

BACKGROUND

The Des Moines and Raccoon Rivers Feasibility Study was initiated in September 1999 to identify opportunities for flood damage reduction within the City of Des Moines.

The study team has been seeking to identify the best combination of alternatives to provide a *comprehensive flood damage reduction system* for the community. Once identified, the team will evaluate the potential alternatives that may qualify for Federal cost-sharing.

The intent of this second Des Moines and Raccoon Rivers Feasibility Study newsletter is to provide an update on the overall study progress.

STUDY PROGRESS

The first phase of the study, detailed hydrologic and hydraulic modeling, will soon be completed. The modeling will provide rainfall, runoff, and river flow analysis.

To support this effort, the City has developed cross sections of the Des Moines River, Raccoon River, Four Mile Creek (to include 7th Ward Ditch), and Walnut Creek using Global Positioning System (GPS) equipment and conventional surveying equipment.

The cross-section information is being used in computer models that calculate water levels along the rivers and creeks which will be used to evaluate system improvements. New flood level estimates have been completed for the Des Moines River, Raccoon River, and Walnut Creek, and the flood level estimates for Four Mile Creek and 7th Ward Ditch are expected to be completed in January 2002.

The study team (Corps of Engineers and City of Des Moines) has started the second phase of the study. During this phase, the study team will gather data and analyze specific sites within the study area. The team will develop and evaluate flood damage reduction alternatives that meet the engineering, economic, environmental, cultural, and social feasibility criteria.

The following paragraphs discuss the status of the specific areas to be evaluated as part of the comprehensive flood damage reduction plan.

Birdland Park Levee – The Birdland Park area contains 170 acres of residential and commercial property, including the North High School complex and Birdland City Park. The levee was overtopped during the 1993 flood, causing extensive flood damages. Levee alignment and improvement alternatives are being evaluated using a range of possible levee heights.

Central Place Levee – The Central Place Business District, on the near north side of the City, contains numerous commercial properties. The levee built to protect the area was overtopped during the 1993 flood, causing extensive flood damages. Since 1993, the City has undertaken several measures to improve the level of protection provided by the levee. The study team is evaluating additional levee improvement alternatives and a range of possible levee heights.

Downtown Levee System – The downtown levee system contains three major reaches of levee which protect the right and left banks of the Des Moines and Raccoon Rivers. The Corps of Engineers constructed these levees in the 1960's and early 1970's. The protected areas contain over 1,800 acres of highly urbanized commercial, retail, industrial, residential, and public facilities at the City's central business core. Study team members are looking at the reliability of the existing levee system and are developing conceptual plans for providing increased protection for the affected area. Additionally, the study team is assessing the number of sandbag and gated closures that need to be made, manpower required, and available warning response times. The City of Des Moines is reviewing its emergency response capabilities as well. The study team also is evaluating the existing levees located along the Raccoon River upstream of Fleur Drive to determine if any further improvements may be warranted.

Walnut Creek at Grand Avenue – Walnut Creek flows through an 84-square-mile watershed located in the western City suburbs and in Dallas County. The West Des Moines – Des Moines Local Flood Protection Project provides protection to the west bank floodplain areas near Walnut Creek's confluence with the Raccoon River. The area of concern is the unprotected developed floodplain area located on the east bank of the creek in the vicinity of Grand Avenue in Des Moines. Alternatives to provide flood protection are being evaluated.

Four Mile Creek – The Four Mile Creek 100 year floodplain contains approximately 270 structures including houses, mobile homes, and businesses. The area has experienced frequent flash flooding with very little emergency response time. The City has installed a flood-warning system to allow adequate time to evacuate people from the flood area; however, there is not adequate response time to protect properties that have been damaged repeatedly over the years. The City has undertaken an effort, in cooperation with the Federal Emergency Management Agency (FEMA), to relocate residents and remove some flood-prone structures from the floodplain in the Williams Street area. The May 1975 Corps of Engineers report on Four Mile Creek will be reevaluated to determine if any structural and/or non structural flood protection alternatives are justified.

7th Ward Ditch South of University Avenue – The 7th Ward Ditch is a nine-square-mile drainage area on the near east side of Des Moines. Low-lying developed properties in this area and downstream towards the confluence with Four Mile Creek frequently experience poor drainage and backwater flooding from Four Mile Creek. The study team will develop and evaluate conceptual alternatives for flood damage reduction along 7th Ward Ditch south of University Avenue.

The study team will continue to develop and evaluate alternatives for the areas discussed above. These alternatives will be available for viewing at a public open house (see "Open House Planned" below).

AERIAL MAPPING COMPLETED

Aerial topography with 2-foot contours is completed and available for use. This information will be used to develop alternatives and to create floodplain maps to show areas that could be flooded in the future.

OPEN HOUSE PLANNED

A public open house will be held in the spring of 2002. All interested persons will have the opportunity to meet with City of Des Moines and Corps of Engineers study team members to discuss, and provide comments on, the study alternatives identified to date. After the open house, the comments heard from the public will be analyzed and provided to the study team.

Additional information about the open house will be mailed and added to the study's website approximately one month before the open house. A summary of the open house will be provided in a follow-on newsletter.

STUDY INFORMATION AVAILABLE ON THE INTERNET

Information about the Des Moines and Raccoon Rivers Feasibility Study, including a map of the study area and study newsletters, is located on the Rock Island District's website. Draft flood profiles will be available soon on the website. The website is located at the following address: http://www.mvr.usace.army.mil/pdw/DM/Raccoonriver/Feasibility/Study/mainpage.htm

PUBLIC INVOLVEMENT COMMENTS/QUESTIONS

We welcome your input. If you have comments and/or questions regarding this study, please contact Mr. Dennis Hamilton, Project Manager, by telephone at 309/794-5634, fax at 309/794-5710, or e-mail at dennis.s.hamilton@usace.army.mil

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District Engineer
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ATTN: CEMVR-PM-M (Hamilton)
Clock Tower Building - P.O. Box 2004
Rock Island, Illinois 61204-2004

The contact for the City of Des Moines is Mr. Scott Ralston. Mr. Ralston may be reached at:

City of Des Moines Engineering – Armory Building
602 East First Street
Des Moines, Iowa 50309
515/283-4954
E-mail: SARal[illegible]@ci.des-moines.ia.us

If you are aware of someone who may wish be added to the study's mailing list to receive this newsletter (or our initial newsletter dated February 2000) and future study mailings, please ask him/her to contact Mr. Ralston or Ms. Sue Simmons, Rock Island District, Corps of Engineers. Ms. Simmons may be contacted at the Rock Island District address listed above, by telephone at 309/794-5573, or by e-mail at sazanne.r.simmons@usace.army.mil

US Army Corps of Engineers
Rock Island District

DES MOINES AND RACCOON RIVERS FEASIBILITY STUDY NEWSLETTER

December 2002

PUBLIC PARTICIPATION ENCOURAGED AT JANUARY OPEN HOUSE

The City of Des Moines and the U.S. Army Corps of Engineers invite all interested persons to attend an open house on January 14, 2003 at the Botanical Center in Des Moines. Please see page 6 for details.

STUDY BACKGROUND

The Des Moines and Raccoon Rivers Feasibility Study was initiated in September 1999 to identify opportunities for flood damage reduction within the City of Des Moines. The feasibility study is being conducted by a partnership of the City of Des Moines and the Rock Island District Corps of Engineers.

The study team is seeking to develop and evaluate the best combination of alternatives to provide a comprehensive flood damage reduction system for the community. Once identified, the team will evaluate the potential alternatives that may qualify for Federal cost-sharing. The feasibility study will result in the preparation of a feasibility report that will make recommendations to Congress regarding Federal participation in a flood damage reduction project. Provided the project is authorized by Congress and funds are made available, a Federal project or projects could be implemented with the Federal Government funding up to 65% of the project cost.

The purpose of this third study newsletter is to announce the January 2003 public open house and to provide an update on Phase 2 of the study

STUDY PROGRESS

During the first phase of the study, most of the detailed hydrologic and hydraulic modeling was completed. Computer models are being used to calculate potential water surface (flood) levels along the rivers and creeks. Those levels will be used in evaluating system improvements. New water surface profiles have been completed for the Des Moines River, Raccoon River, and Walnut Creek, and the water surface level estimates for Four Mile Creek and Leetown Creek (formerly known as 7th Ward Ditch) are expected to be completed in January 2003.

The study is now in the second phase. In this phase, the study team is gathering data and analyzing specific sites (reaches) within the study area. A map showing the location of each reach is shown on page 6 of this newsletter. The team is developing and evaluating flood damage reduction alternatives for each reach that meet Federal engineering, economic, environmental, cultural, and social feasibility criteria. In general, the alternative plan that results in the greatest net benefits (benefits minus costs) and is consistent with existing environmental laws and regulations will be selected.

The following paragraphs discuss the status of the specific reaches being evaluated as part of the comprehensive flood damage reduction plan.

Reach 1 – Birdland Park Levee – The Birdland Park area, in the north-central part of the City, contains 170 acres of residential and commercial property, including the North High School complex and Birdland City Park. The existing levee along the Des Moines River, built by the City of Des Moines in the 1950's, had a closure fail during the 1993 flood, causing extensive flood damages. (A closure is an intentional opening through levees and floodwalls for streets, railroads, utilities, and other facilities, that must be closed or sealed during floods.) In addition, study investigations have found a variety of structural deficiencies within the existing levee embankment

Preliminary design work has been completed on alternatives to reconstruct the levee system in accordance with Corps of Engineers standards. This design work also included studies on raising the levee to improve its performance. Feasibility level cost estimates have been completed for these alternatives. Project costs, including final design, construction, and real estate range from $3.5 to $5.1 million. The flood damage reduction benefits associated with these levee improvements are currently being computed.

If the benefits exceed the costs, a recommendation will likely be made to implement a cost-shared Federal project to improve the Birdland Park levee system. The Corps of Engineers would develop the construction plans and oversee the construction of the project. The City would continue to own, operate, and maintain the levee system.

Reach 2 – Central Place Levee – The Central Place Business District, on the near north side of the City, is home to a variety of businesses. The study has identified approximately 110 business properties within the floodplain of the Des Moines River in the Central Place area. The existing levee system, built by the City of Des Moines in the 1950's, was overtopped during the 1993 flood event, causing more than $20 million of flood damages. In addition to the Des Moines River overtopping the levee in 1993, study investigations have found a variety of structural deficiencies within the existing levee embankment.

Preliminary design work has been completed on alternatives to reconstruct the levee system in accordance with Corps of Engineers standards. This design work also included studies on raising the levee to improve its performance. Feasibility level cost estimates have been completed for these alternatives. The estimated project cost, including final design, construction, and real estate, is in the range of $3.3 million to $5.6 million. The flood damage reduction benefits associated with these levee improvements are currently being computed.

If the benefits exceed the costs, a recommendation will likely be made to implement a cost-shared Federal project to improve the Central Place levee system. The Corps of Engineers would develop the construction plans and oversee the construction of the project. The City would continue to own, operate, and maintain the levee system.

Reaches 3, 4, and 5 – Downtown Levee System – The downtown levee system contains three major reaches of levees and floodwalls (east, west, and south) along the banks of the Des Moines and Raccoon Rivers. The Corps of Engineers constructed these levees and floodwalls in the 1960's and early 1970's to protect over 1,800 acres of highly urbanized commercial, retail, industrial, residential, and public facilities at the City's central business core. Although the flooding in 1993 was not high enough to overtop these structures, much of the area was flooded due to the inability to complete all of the closures in advance of the rising floodwaters.

Study team members are evaluating the reliability of the existing levee and floodwall system and developing conceptual designs for providing increased protection for the affected areas. As raising the existing levee and floodwall system are cost-prohibitive, much of the team's focus has been on cost-effective levee and closure improvements. The estimated project costs are being computed at this time and coordinated with a proposed Principal Riverwalk Master Plan. The flood damage reduction benefits associated with these improvements also are currently being computed.

If the benefits exceed the costs, a recommendation will likely be made to implement a cost-shared Federal project to improve the downtown levee system. The Corps of Engineers would develop the construction plans and oversee the construction of the project. The City would continue to own, operate, and maintain the levee system.

As stated above, the Corps of Engineers and the City are coordinating any levee and floodwall improvements with the Riverwalk plan. More information on the Principal Riverwalk is available on the City's website at http://www.dmgov.com under "Hot Topics" on the right side of the page.

Reach 6 – Raccoon River – The Raccoon River Section 205 levee is located south of the Raccoon River west of Fleur Drive. It provides flood protection to 130 acres of urban land, including a mixture of commercial buildings, light industry, and homes located south of the Waterworks Park. The administrative building of the Des Moines Water Works is also included within the protected area. During the 1993 flood, the previous levee system was

overtopped and the area suffered extensive flood damages. A Federal Section 205 project upgraded the City-built levees after the 1993 flood. This system was completed in 2000 and meets or exceeds guidelines of the Federal Emergency Management Agency (FEMA) so that residents do not have to purchase flood insurance. The upgraded levee system would have prevented flooding in 1993.

The study team is evaluating the existing levee to determine the current level of protection and if improvements are warranted. Although the evaluation is not complete, it appears that any further improvements to this recently completed levee system will not be economically justified.

Reach 7 – Des Moines Water Works Levee – The Des Moines Water Works water treatment plant is located on the south bank of the Raccoon River immediately west of Fleur Drive. A City-constructed ring levee embankment protects the plant. During the 1993 flood, the levee system was overtopped and water service to the Des Moines metropolitan area was interrupted for approximately two weeks. Immediately after the flood, the Des Moines Water Works undertook raising the levee approximately 5 to 6 feet. Additionally, a swing gate closure structure was constructed at the access road and railroad spur entering the plant. Previously, the Water Works had installed a temporary clay plug to make this levee closure. The raised levee height is approximately 1 foot higher than the adjacent Reach 4 levee system.

The study team is evaluating the performance of the existing levee to determine if improvements are warranted. Although the evaluation is not complete, it appears that any further improvements to this recently completed levee system will not be economically justified.

Reach 8 – Des Moines–West Des Moines Levee – The West Des Moines–Des Moines Local Flood Protection Project levee system provides protection to the west bank floodplain areas of Walnut Creek and north bank floodplain areas of the Raccoon River upstream of Walnut Creek. This system, which protects 900 acres of commercial, residential, and industrial properties in the Cities of Des Moines and West Des Moines, was completed in 1999 and meets or exceeds guidelines of FEMA so that flood insurance is not required. This area experienced extensive flooding in 1993. The recently completed levee system would have prevented these flood damages from occurring.

The study team is evaluating the performance of the existing levee system to determine if improvements are warranted. Although the evaluation is not complete, it appears that any further improvements to this recently completed levee system will not be economically justified.

Reach 9 – Walnut Creek at Grand Avenue – Walnut Creek flows through an 85-square-mile watershed located in the western metropolitan suburbs and in Dallas County. The West Des Moines–Des Moines Local Flood Protection Project provides protection to the west bank floodplain areas near Walnut Creek's confluence with the Raccoon River. The area of concern is the unprotected developed floodplain area located on the east bank of the creek in the vicinity of Grand Avenue in Des Moines. This area experienced frequent low-level flooding in the past.

Preliminary design work has been completed on a plan to construct a levee along the east bank of Walnut Creek at the same height as the existing levee and floodwall system on the west bank. The estimated project cost, including final design and construction, is approximately $3 million. Real estate costs are not included in this amount. The flood damage reduction benefits associated with these levee improvements have been determined to be less than the estimated cost. Thus, it appears that any structural protection in this area will not be economically justified.

Reach 10 – Four Mile Creek – Four Mile Creek is a 121-square-mile watershed that drains much of north-central Polk County. The stream flows southerly through the eastern part of the city, emptying into the Des Moines River. The Four Mile Creek 100-year floodplain contains approximately 200 structures including houses, mobile homes, and businesses that are dispersed at several locations along the stream. The City has undertaken an effort, in cooperation with FEMA, to relocate residents and remove some flood-prone structures.

Evaluation of several selected levee alignments does not appear to warrant Federal participation in a construction project. These preliminary results are compatible with a 1975 Corps of Engineers study of this area.

Reach 11 – Leetown Creek South of University Avenue – Leetown Creekway is a nine-square-mile drainage area on the near east side of Des Moines. Low-lying developed properties in the area west and south of the Iowa State Fairgrounds and downstream towards the confluence with Four Mile Creek frequently experience poor drainage and backwater flooding from Four Mile Creek.

The study team is developing and evaluating conceptual levee, detention basin, and pump station alternatives to reduce flood damage in the area south of University Avenue along the Leetown Creek. The study team also will develop and evaluate alternatives to reduce flooding in the area south of Leetown Creek currently protected by the Red Rock Remedial Works levee. Water levels have not yet been computed for this area.

AERIAL MAPPING COMPLETED

Aerial topography with 2-foot contours is completed and available for use. This information is being used to develop alternatives and to create floodplain maps to show areas that could be flooded in the future.

WETLAND EVALUATION

Wetland boundaries within the study reaches were identified in the spring of 2002. These boundaries will be shown on the study maps to be on display at the January 14th Open House. As the study alternatives are finalized, a functional analysis will be performed for any wetlands proposed to be impacted by the project. Compensatory mitigation alternatives will be developed to replace the lost habitat value of any unavoidable wetland impacts.

OPEN HOUSE PLANNED

You are invited to attend an open house on January 14, 2003. The open house will be held in the Oak Room at the Des Moines Botanical Center, 909 East River Drive, Des Moines, Iowa.

The purpose of the open house is to provide information on the study status and the alternatives being evaluated for flood damage reduction and to gather your input on these alternatives.

Two identical open house sessions will be held. Representatives from the City of Des Moines and from the Corps of Engineers will be available *at any time* from 1-3 p.m. and 5-8 p.m. to meet with you to discuss on a one-to-one basis information on the alternatives. You are encouraged to attend either open house session, visit the display areas, talk to City and Corps of Engineers representatives, and provide comments.

Open house displays will include a continuously running PowerPoint presentation that will provide study information; maps of selected study reaches that will show the 100-year floodplain, existing and potential levee alignments, and wetland locations; and flood photographs. A detailed map will be provided as a handout.

Your comments are important. You also will receive a comment sheet to complete at the open house. Comments received will be analyzed and provided to the study team. The next study newsletter will contain an open house summary, including a summary of the comments.

The open house will be a scoping meeting and will partially fulfill the National Environmental Policy Act's scoping requirements. Comments received from Federal, State, and Natural Resource agencies and the public will be considered in the Environmental Assessment.

STUDY SCHEDULE

The Draft Des Moines and Raccoon Rivers Feasibility Report is scheduled to be completed and available for public review in February 2004.

STUDY INFORMATION AVAILABLE ON THE INTERNET

The website for the Des Moines and Raccoon Rivers Feasibility Study has been updated to include additional study information, study documents, study team points of contact, and related websites.

Open house material, including the PowerPoint presentation, will be placed on the website after the open house. During the public review period in 2004, the draft report will be available for viewing on the website. Flood profiles will be available after they are finalized.

The website is located at the following address: http://www.mvr.usace.army.mil/DesMoines/FP

PUBLIC INVOLVEMENT COMMENTS/QUESTIONS

We welcome your input. If you have comments and/or questions regarding this study, please contact Mr. Dennis Hamilton, Project Manager, by telephone at 309/794-5634, fax at 309/794-5710, or e-mail at dennis.w.hamilton@usace.army.mil.

If you prefer, you may write to Mr. Hamilton at the following address:

District Engineer
U.S. Army Engineer District, Rock Island
ATTN: CEMVR-PM-M (Hamilton)
Clock Tower Building - P.O. Box 2004
Rock Island, Illinois 61204-2004

The point of contact for the City of Des Moines is Mr. Scott Ralston, Storm Water Engineer. Mr. Ralston may be reached at:

City of Des Moines Engineering – Armory Building
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Des Moines, Iowa 50309
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E-mail: SARalston@dmgov.org

HELP US SPREAD THE WORD

If you are aware of someone who may wish be added to the study's mailing list to receive this newsletter, previous newsletters, and/or future study mailings, please ask him/her to contact Mr. Ralston or Ms. Sue Simmons, Rock Island District, Corps of Engineers. Ms. Simmons may be contacted at the Rock Island District address listed on this page, by telephone at 309/794-5573, or by e-mail at susanne.r.simmons@usace.army.mil.

US Army Corps of Engineers
Rock Island District

DES MOINES AND RACCOON RIVERS FEASIBILITY STUDY NEWSLETTER

CITY OF DES MOINES

March 2004

STUDY BACKGROUND

The Des Moines and Raccoon Rivers Feasibility Study, conducted by a partnership of the City of Des Moines and the Rock Island District Corps of Engineers, was initiated in September 1999. The purpose of the study is to identify opportunities for flood damage reduction within the City of Des Moines.

This fourth study newsletter reviews the feasibility study process and provides an update on the study progress.

SIX-STEP STUDY PROCESS

The U.S. Army Corps of Engineers follows a six-step planning process. This process is generally followed by all federal water resources agencies.

The six steps are:

STEP 1 - IDENTIFY PROBLEMS AND OPPORTUNITIES
- What are the water related problems and needs of the study area?
- Are there any opportunities for improvement of water resources?

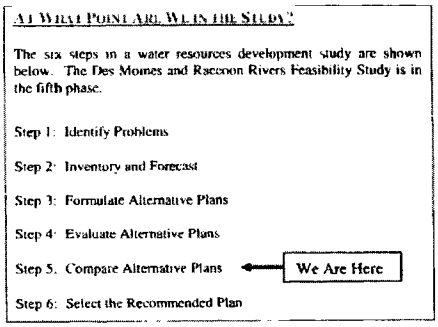
STEP 2 - INVENTORY AND FORECAST CONDITIONS
- Develop an inventory and forecast of critical resources (physical, demographic, economic, social, etc.) relevant to the problems and opportunities.

STEP 3 - FORMULATE ALTERNATIVE PLANS
- The first plan considered is No Action.
- Identify specific ways to achieve the planning objectives to address and reduce the problems identified and realize the opportunities.
- An alternative plan consists of a system of structural and/or nonstructural measures, strategies, or programs formulated to meet, fully or partially, the identified study planning objectives.

STEP 4 - EVALUATE ALTERNATIVE PLANS
- The Corps' evaluation is a comparison of the proposed improvements vs. no improvements for each alternative

STEP 5 - COMPARE ALTERNATIVE PLANS
- Alternative plans (including the No Action plan) are compared against each other, with emphasis on the outputs and effects that will have the most influence in the decision-making process.
- Beneficial and adverse effects of each plan must be compared.

STEP 6 - SELECT A PLAN
- The recommended plan must be shown to be preferable to taking no action (if no action is not recommended) or to implementing any of the other alternatives considered during the planning process.
- The culmination of the planning process is the selection of the recommended plan or the decision to take no action.



STUDY UPDATE

The Corps of Engineers and City of Des Moines study team has studied several areas or reaches throughout Des Moines and has evaluated draft alternatives for flood damage reduction to determine if any of the alternatives qualify for federal cost sharing. To do so, a project must be environmentally acceptable and the benefits must exceed the costs of the project.

The reaches that have been studied are:

- Reach 1 – Birdland Park Levee
- Reach 2 – Central Place Levee
- Reaches 3, 4, & 5 – Downtown Levee System
- Reach 6 – Raccoon River (Valley Drive area)
- Reach 7 – Des Moines Water Works Levee
- Reach 8 – Des Moines-West Des Moines Levee
- Reach 9 – Walnut Creek at Grand Avenue
- Reach 10 – Four Mile Creek
- Reach 11 - Leetown Creek South of University Avenue

The status of each of the areas, e.g., whether or not they are being considered for further study, is described below.

STUDY STATUS

The study team is completing comparisons of the alternatives and is working on developing a recommended plan. New flood profiles for the Des Moines River, the Raccoon River, Walnut Creek, Four Mile Creek, and Leetown Creek have been completed and floodplain maps of these areas have been provided to the City. The December 2002 newsletter included a description of each of the 11 reaches listed above. Following is a summary of the activities.

Reach 1 – Birdland Park Levee – The primary alternatives under consideration involve reconstruction of the existing levee from Riverview Park to Saylor Road to provide improved flood protection. The study team has not yet determined if a federal project is justified.

Reach 2 – Central Place Levee – The primary alternatives under consideration involve reconstruction of the existing levee to provide improved flood protection from Second Avenue to I-235. The study team has determined that a federal project to improve the levee system is likely justified.

Reaches 3, 4, and 5 – Downtown Levee System – The primary alternatives under consideration involve improving and reconstructing existing levee closures on the levees along the Des Moines and Raccoon Rivers to provide more reliable flood protection. The downtown levees are primarily located south of I-235 and east of Fleur Drive, downstream almost to the Des Moines Wastewater Treatment Facility.

Closures are locations where roads, railroads, pipes, and utilities cross through the levee. These closures must be manually closed during a flood event (using gates, valves, sandbags, or other materials) to prevent flooding. Taking care of these closures during a flood event requires a considerable amount of manpower in a short period of time and can increase the flood risk to a community. The study team has not yet determined if a federal project to improve the closures is justified.

Reach 6 – Raccoon River (Valley Drive area) – No further improvements to the existing federal levee in this area appear to be justified.

Reach 7 – Des Moines Water Works Levee – No further improvements to the existing levee around the water works appear to be justified.

Reach 8 – Des Moines–West Des Moines Levee – No further improvements to the existing federal levee in this area appear to be justified.

Reach 9 – Walnut Creek at Grand Avenue – No federal project appears to be justified to protect the property on the east side of Walnut Creek near Grand Avenue.

Reach 10 – Four Mile Creek – No federal project to construct structures such as dams or levees appears to be justified to protect property in the Four Mile Creek floodplain. The study team has not yet determined if any nonstructural alternatives, such as relocating homes, is justified.

Reach 11 – Leetown Creek South of University Avenue – No federal project appears to be justified to protect property in this area.

PUBLIC INPUT RECEIVED AT OPEN HOUSE

On January 14, 2003, an open house for the Des Moines and Raccoon Rivers Feasibility Study was held at the Des Moines Botanical Center. All persons who had an interest in the study were invited to attend. The purpose of the open house was to provide information on the study status and the alternatives being evaluated for flood damage reduction and to gather the public's input on these alternatives. The study team is considering public input as they continue to look at the draft alternatives. Comments from the public will also will be part of the Environmental Assessment (as part of the National Environmental Policy Act (NEPA) process).

Two identical open house sessions were held – one in the afternoon and one in the evening. Representatives from the City of Des Moines and from the Corps of Engineers met with members of the public on a one-to-one basis to discuss information on the alternatives. In addition, study displays were available for viewing.

Open house attendees were asked to fill out a comment sheet. Overall, comments were very favorable regarding the open house format and displays. Within the environmental arena, study area residents recognized the importance and challenge of balancing the protection of people and property with the protection of the ecosystem. The major concerns centered around impacts to wetlands and farmland, and reducing rainwater runoff.

Other issues identified include levee improvements – especially in the Central Place and Birdland Park areas, limiting floodplain development, potential floodwater damage impacts downstream of Des Moines, protection of the downtown business district, and the handling of interior drainage problems.

Impacts and damages resulting from the 1993 flood event in Des Moines were a major impetus for the initiation of this study. When asked if the study was addressing those impacts and concerns, nearly everyone who responded agreed that the study appears to have identified areas in need of improvement, and the final outcome will determine if those needs are addressed.

STUDY SCHEDULE

Work in 2002 was delayed by eight months due to a shortage of federal funds. The current study schedule shows the Draft Des Moines and Raccoon Rivers Feasibility Report scheduled to be completed and available for public review in the fall of 2004.

The next significant opportunity for public input will be in the fall 2004 timeframe, when a public meeting will be held during the public review phase of the study.

STUDY INFORMATION AVAILABLE ON THE INTERNET

The website for the Des Moines and Raccoon Rivers Feasibility Study includes study information, study documents, study team points of contact, and related websites.

The PowerPoint presentation shown at the January 2003 open house is provided on the website. In addition, the draft report will be available on the website during the public review period, currently scheduled for fall 2004.

The website is located at the following address: http://www.mvr.usace.army.mil/DesMoinesFP/

PUBLIC INVOLVEMENT COMMENTS/QUESTIONS

We welcome your input. If you have comments and/or questions regarding this study, please contact Mr. Dennis Hamilton, Project Manager, by telephone at 309/794-5634, fax at 309/794-5710, or e-mail at dennis.w.hamilton@usace.army.mil.

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US Army Corps of Engineers

News Release

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Public Affairs Office
Contact: Justine Barati
Phone: (309) 794-5204

Corps Seeks Input on Flood Damage Reduction Plan for the Des Moines and Raccoon Rivers

ROCK ISLAND, ILL. – The Corps of Engineers and the City of Des Moines are asking the public to join them at an open house to learn about, and discuss, the proposed alternatives for flood damage reduction on the Des Moines and Raccoon Rivers.

The open house is scheduled for Jan. 14. It will be held in the Oak Room at the Des Moines Botanical Center, 909 E. River Dr., Des Moines, Iowa, from 1 p.m. to 3 p.m. and 5 p.m. to 8 p.m. The public is invited to visit the open house sessions at any time between the designated hours. The sessions will be identical.

At the open house, representatives from the city and the Corps will be available to discuss the project on a one-to-one basis. Participant comments will be used by the study team to assist in developing flood damage reduction recommendations for the community.

The areas (reaches) being discussed include: the Birdland Park Levee (Reach 1); the Central Place Levee (Reach 2); the Downtown East Levee (Reach 3); the Downtown West Levee (Reach 4); the Downtown South Levee (Reach 5); the Raccoon River Section 205 Levee (Reach 6); the Des Moines Water Works Levee (Reach 7); the Des Moines-West Des Moines Levee (Reach 8); the Walnut Creek at Grand Avenue (Reach 9); the Four Mile Creek (Reach 10); and the Leetown Creek (Reach 11).

Some of the specific alternatives being discussed include:

1. Reconstructing the Birdland Park and Central Place levee systems in accordance with Corps standards, and possibly raising the levees to improve their performance;
2. Developing cost-effective levee and closure improvements for the Downtown Levee System;

3. Constructing a levee, detention basin, and pump station in the area south of University Avenue along the Leetown Creek; and,
4. Developing alternatives to reduce flooding in the area south of Leetown Creek, currently protected by the Red Rock Remedial Works levee.

For any flood damage reduction alternative to be justified as a federal project, the benefits of the project must exceed the construction costs. The study team will evaluate alternatives that may qualify for federal cost sharing and prepare a report that will make recommendations to Congress regarding federal participation in a flood damage reduction project. The Draft Des Moines and Raccoon Rivers Feasibility Report is scheduled to be completed and available for public review in February 2004.

If you have any questions or comments about the study, please call Dennis Hamilton, Project Manager, Corps of Engineers, at 309-794-5634 or e-mail him at dennis.w.hamilton@usace.army.mil You may also contact Scott Ralston, Storm Water Engineer, City of Des Moines, at 515-283-4954 or e-mail him at SARalston@dmgov.org

If you have questions about the open house, please call Sue Simmons at 309-794-5573 or e-mail her at suzanne.r.simmons@usace.army.mil

-- end --

DES MOINES/RACCOON RIVERS FEASIBILITY REPORT
DES MOINES/RACCOON RIVERS STUDY
POLK COUNTY, IOWA

APPENDIX I

404(B)(1) EVALUATION

DES MOINES/RACCOON RIVERS FEASIBILITY REPORT
DES MOINES/RACCOON RIVERS STUDY
POLK COUNTY, IOWA

APPENDIX I

404(B)(1) EVALUATION

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APPENDIX I
404(B)(1) EVALUATION

1.1 PROJECT DESCRIPTION

A. LOCATION

The proposed levee construction project is located along the Des Moines and Raccoon Rivers in the City of Des Moines, Polk County, Iowa.

B. GENERAL DESCRIPTION

The proposed work involves reconstruction of two levee reaches and the construction of 23 permanent closure structures. The levee reaches involve disturbance to Waters of the United States, so they are addressed in this Clean Water Act Section 404(b)(1) Evaluation.

C. AUTHORITY AND PURPOSE

The authority of the levee construction project is Section 216 of the 1970 Flood Control Act. The purpose is to provide flood protection to the City of Des Moines. The authority and purpose of the evaluation portion of this document is to comply with Section 404 of the Clean Water Act pertaining to guidelines for placement of dredged or fill material into the Waters of the United States. This evaluation, in conjunction with the EA, will assist in analysis of the alternatives for this project. Further, this evaluation will provide information and data to the Iowa Department of Natural Resources (IDNR), which is the state water quality certifying agency demonstrating compliance with state water quality standards. This will aid in the decision-making process concerning the Section 401 water quality certification.

D. GENERAL DESCRIPTION OF DREDGED MATERIAL

Placement of borrow material will occur within Waters of the United States to reconstruct the Birdland levee reach. In addition, tree trunks will be removed to a distance of 15' out from both the Birdland and Central Place levee reaches, which will cause minimal soil disturbance. The Central Place levee will be constructed with materials obtained from the existing levee and all fill material will be placed within the footprint of the existing levee. The Birdland levee will be constructed with stockpiled clay material. Appendix C, *Engineering Design,* states that approximately 100,000 cubic yards of borrow material will be used at the Birdland levee, along with approximately 6,000 cubic yards of riprap. Only a small portion of those amounts will be placed within existing wetlands.

Phase IIA HTRW sampling of the levee and adjacent forested area at Central Place, the stockpiled material to be used to construct the Birdland levee, and the existing Birdland levee was undertaken in January, 2004. Complete detailed methods and results can be found in Appendix E, *Hazardous, Toxic and Radioactive Waste.* Contaminants were found in the existing substrate within the project area, although no contaminated material is proposed to be brought to the project area for construction purposes, and no contaminated material will be placed in any wetlands or other waters of the United States.

E. DESCRIPTION OF THE PROPOSED PLACEMENT SITES

The acreage and type of wetlands and waters to be impacted at the Birdland and Central Place levee reaches can be found in the main report and in the mitigation plan. In summary, approximately 0.8 acres of emergent wetlands, 0.6 acres of scrub-shrub and forested wetlands, and 2.7 acres of open water will be permanently filled by the preferred Birdland alignment, and approximately 0.2 acres of forested wetlands will be cleared and maintained in a mowed state. The Birdland alignment may shift, however, so the maximum wetland impact acreage is 1.5 acres of emergent wetlands, 0.8 acres of scrub-shrub and forested wetlands, and 3.8 acres of open water that could be permanently filled by the Birdland levee, along with the approximately 0.2 acres of forested wetlands to be cleared and maintained in a mowed state. In addition, approximately 1.2 acres of forested wetlands will be cleared and maintained in a mowed state by the preferred Central Place alignment.

F. DESCRIPTION OF PLACEMENT METHOD

The levees will be constructed with standard engineering equipment such as excavators, bulldozers, scrapers, compaction equipment, and material will be carried by dump trucks. Sound engineering practices will be followed during all phases of project construction.

1.2 FACTUAL DETERMINATIONS

A. PHYSICAL SUBSTRATE DETERMINATIONS

1. Substrate Elevation and Slope.

The ground surface at the base of the Birdland levee is approximately 20-22 ft Des Moines City Datum at the location of the Kiwanis Island. The ground surface elevation varies down the length of the existing levee between approximately 18-22 ft. along the riverward side of the levee and 25-30 ft. along the landward side of the levee. The proposed top elevation of the Birdland levee is 35-37.1 ft. The ground surface at the base of the Central Place levee is approximately 22 feet on the landward side of the levee and 18 feet on the riverward side of the levee although this varies along the length of the existing levee. The proposed top elevation of the Central Place levee is 34.2-36.6 ft.

2. Sediment Type.

The Polk County soil survey describes the Birdland levee area near the lagoons and wetland impact areas as being a Coland clay loam. The Central Place levee alignment is described as a Nodaway silt loam.

3. Dredged/Fill Material Movement.

The levees will be stabilized immediately after construction, so no dredged or fill material is expected to move after construction. During construction, silt fences and other appropriate measures will be used to ensure that sediments do not migrate from the levee to the adjacent wetlands.

4. Physical Effects on Benthos.

The only open water areas to be filled in are located within the lagoons along the proposed Birdland levee. The lagoon surrounding the Kiwanis nature island does not contain any emergent or submergent vegetation in the location of the proposed levee alignment. This lagoon also has no surface water connection to the Des Moines River. A minimal benthic population is expected at the site. The lagoon at the southern end of the Birdland reach is vegetated with emergent and submergent vegetation and has a surface water connection to the Des Moines River; therefore, a more diverse benthic population could be expected in the area to be filled for levee construction. No open water areas will be filled during construction of the Central Place levee alignment.

5. Actions Taken to Minimize Impacts.

As described in paragraph 3 above, the levees will be stabilized after construction, and silt fences will be used during construction to keep sediments on-site.

B. WATER CIRCULATION AND FLUCTUATION

1. Water.

The only area of open water to be filled as part of this project is the approximately 2.7 – 3.8 acres of open water proposed to be permanently filled in at the Birdland levee reach. This open water would be replaced by land up to 20' above the existing ground level. Outside of the levee construction site, the effluent may have a temporary impact on water chemistry, water temperature, pH, clarity, color, odor, taste, dissolved gas levels, nutrient levels or organic matter influxes that may cause negative impacts to aquatic organisms within the lagoons. Impacts to the human population concerning the suitability of this water body for human consumption would be negligible. Water-based human recreation would be affected since less natural island shoreline would be available for use by fishermen after the levee is constructed. The aesthetic value of the existing lagoon surrounding the Kiwanis nature island is high, and this will be decreased after construction of the levee that will bisect the island and lagoon. No open water areas will be filled at Central Place.

2. Current Patterns and Water Circulation.

A stormwater discharge pipe currently enters the Birdland lagoon near the Kiwanis Island in the general location of the lagoon. This is a major source of the hydrology of the lagoon. The construction of the levee will prevent stormwater flow to both sides of the lagoon, although ground water discharge is expected to keep both sides filled with water. The lagoon currently does not have much flow, since it is an isolated depression. The lagoon near the southern end of the Birdland reach will be partially filled along its edge through reconstruction of the levee. Since this is along the edge of the larger lagoon, it is not expected to greatly impact current patterns or water circulation within the lagoon, except that less area would be available for the water to flow within the lagoon after construction of the levee. The lagoon near the Kiwanis Island may need to be drawn down to allow for construction of the levee. That would change the water circulation within the lagoon since the water would need to be pumped out of the lagoon, most likely into the Des Moines River. Approximately 1.4 – 2.3 acres of wetlands will be permanently filled at the Birdland levee, and this could impact current patterns and water

circulation during high water, since these wetlands are located in depressions in the landscape. The effect will be minimal, however, since the wetlands are scattered throughout the Kiwanis Island and the lagoon is the major open water area that will determine current patterns and water circulation. Central Place will not have any permanent wetland fill, so no impacts to current patterns or water circulation are expected along that reach.

3. Normal Water Level Fluctuation.

The loss of 2.7-3.8 acres of open water within the two Birdland lagoons will not measurably affect the normal water levels within the Des Moines River or the lagoons themselves. The filling of open water would reduce the area available for that water to flow, which, when considered cumulatively with other filling projects within the Des Moines River, can have a negative impact during floods when high water loses its traditional floodplain. The overall project will increase flood protection for the City of Des Moines, however. The 1.4-2.3 acres of permanent wetland fill within the Kiwanis Island is also not expected to affect the normal water levels within the Des Moines River or the lagoons, although there is a negative cumulative effect of permanent wetland fill when this project is considered with other permanent wetland fills within the developed areas of Des Moines. Central Place will not have any permanent wetland fill, so no impacts to normal water level fluctuation are expected.

4. Actions Taken to Minimize Impacts.

The levees and seepage berms have been kept to the minimum size necessary for the project. A floodplain permit will be obtained from the IDNR prior to construction, and the Corps of Engineers, Rock Island District (the District) will comply with all applicable requirements.

C. SUSPENDED PARTICULATE/TURBIDITY DETERMINATIONS

1. Effects on Physical and Chemical Properties of the Water Column.

The impacts to the water column at the lagoons near Birdland from placement of the levee reach into the lagoons would be considerable. The water column itself within the 2.7-3.8 acres of open water to be filled would be replaced by sediments used to construct the levee.

A minimal amount of sediment could be expected to enter the lagoons adjacent to the construction site, and this sediment would move into the adjacent water column. Any minimal suspended sediment impacts on turbidity would disperse in open water further away from the construction site.

The permanent filling of 1.4-2.3 acres of wetlands within the Kiwanis Island could have a negative effect on the physical and chemical properties of the water column since wetlands are known to have the capacity to filter sediments and nutrients. Most of the wetlands within the island will remain, however, so only minimal filtering functions will be impacted.

Approximately 1.2 acres of wetlands at Central Place and 0.2 acres of wetlands at Birdland will have their wetland vegetation removed and replaced with mowed grass. This low grass will not have the same filtering capacity of the denser and more diverse wetland vegetation, although

the impact of the vegetation change to the Des Moines River water column is expected to be minimal.

2. Effects on Biota.

Any aquatic biota living within the Birdland wetlands or lagoons would be impacted through placement of sediments within and adjacent to the levee construction site. Little or no aquatic vegetation exists within the lagoon near the Kiwanis Park, so no significant effects are expected within that lagoon. The lagoon at the southern end of the Birdland reach does contain aquatic vegetation, so the filling of a portion of that lagoon and any secondary impacts on turbidity within the lagoon from levee construction will have more significant impacts on biota.

The removal of wetland vegetation from Central Place and Birdland will have a negative impact on any biotic communities that currently exist within those areas.

3. Actions Taken to Minimize Impacts.

The levees will be stabilized through seeding and the use of silt fence as necessary to contain all of the construction sediments.

D. CONTAMINANT DETERMINATIONS

A Phase IIA HTRW analysis was done of the existing levee material at the Birdland and Central Place reaches, and of the stockpiled material to be used to construct the portion of new levee reach at Birdland. A minor amount of the stockpiled material may be used at Central Place if there is not enough on-site material to reconstruct the levee. A summary of this analysis can be found in Appendix E. No contaminated material will be placed within waters of the United States as part of this project. Existing information for this project provides a sufficient basis for making factual determinations concerning impacts to waters of the United States.

E. AQUATIC ECOSYSTEM and ORGANISMIC DETERMINATIONS

1. Effects on Plankton and Nekton.

The Birdland lagoons likely contain a population of plankton and nekton, although the population at the lagoon near the Kiwanis Island is likely to be low due to lack of aquatic vegetation within the open water area. Any plankton or nekton located within the area to be permanently filled through construction of the levee would be permanently impacted through the filling of 2.7-3.8 acres of open water.

2. Effects on Benthos.

There would be permanent negative effects on benthos within the 2.7-3.8-acre open water area proposed to be filled with material to construct the Birdland levee.

3. Effects on Aquatic Food Web.

The aquatic food web within the wetlands and open water areas of the Birdland levee reach to be filled would be permanently eliminated through construction of the levee. In addition, the wetlands at Birdland and Central Place that will have wetland vegetation removed will have a

loss of food for species that currently utilize those areas, although they are located directly adjacent to similar areas that will remain fully vegetated.

4. Effects on Special Aquatic Sites.

Special aquatic sites are defined in the Clean Water Act as sanctuaries and refuges, wetlands, mudflats, vegetated shallows, coral reefs, and riffle and pool complexes. Of these, this project will impact wetlands. The wetlands at Central Place to be impacted involve the elimination of structural habitat from the existing wetlands, although the wetland substrate will still exist. Most of the wetlands to be impacted at Birdland involve the placement of material into the wetlands to convert them to parts of the levee reach. The habitat currently found within the wetland impact areas will be eliminated. Approximately 1.6-2.5 acres of emergent, scrub-shrub, and forested wetlands are proposed to be impacted through construction of the Birdland levee reach and approximately 1.2 acres of forested wetlands are proposed to be impacted through construction of the Central Place levee reach. These wetlands currently provide habitat for birds, amphibians, small mammals, and invertebrates. The mitigation plan as described in Section 1 of Appendix G, *Environmental,* is proposed to restore approximately 2.6 acres of forested wetlands and create approximately 2.8 acres of emergent wetlands as mitigation for the project's wetland impacts.

5. Threatened and Endangered Species.

The Birdland levee alignment will likely impact a known Bald eagle roosting tree, and will potentially impact other roosting trees in the vicinity. In addition, the Birdland and Central Place alignments have the potential to impact Indiana bat nesting habitat through removal of upland and wetland trees along the alignments. A survey may be done to determine the impact of the project on those federally threatened and endangered species. Ongoing coordination will continue to take place between the District and the US Fish and Wildlife Service (USFWS) to ensure that the District remains in compliance with the Endangered Species Act. For instance, if an Indiana bat survey is recommended and completed with the result that known Indiana bat habitat will be impacted, the District will likely need to prepare a Biological Assessment so that the USFWS can prepare a Biological Opinion with steps the District must take in order to minimize impacts to the species. These steps would likely include clearing of trees within Indiana bat habitat areas during the winter months when the Indiana bat is not present. See the Environmental and Cultural Resources write-up in Section 4A(1) in the main report for a more detailed discussion.

6. Other Wildlife.

Since the wetlands are located in downtown Des Moines, wildlife usage of the existing wetlands at Birdland and Central Place consists of typical urban species such as songbirds, small mammals, reptiles, and invertebrates. With construction of the project, this habitat would be eliminated since the wetlands would be converted to mowed levees. Over time, however, the compensatory mitigation plan is expected to provide similar habitat as that to be impacted. Portions of the mitigation effort will take place near the Central Place alignment, so the wildlife usage of the mitigation site will be similar to the wildlife usage of the impacted wetlands and uplands. The rest of the mitigation effort will take place outside of Des Moines at the Chichaqua mitigation site, however, so a wildlife community different than the community that

currently utilizes the wetlands and uplands at the impact areas is expected to utilize the wetlands and uplands at that mitigation site.

7. Actions Taken to Minimize Impacts.

The original alignment, Alignment 3, of the Birdland reach was eliminated from consideration partially due to the larger amount of wetland and open water impacts associated with that alternative.

F. PROPOSED PLACEMENT SITE DETERMINATIONS

1. Mixing Zone Determinations.

The only open water discharges associated with this project are for levee construction. The sediments will be contained within the levee construction site, so no mixing zone is expected to be required.

2. Determination of Compliance with Applicable Water Quality Standards.

A Section 401 permit application will be submitted to the IDNR. The District will undertake all actions necessary to comply with applicable water quality standards as listed in the 401 Water Quality Certification.

3. Potential Effects on Human-Use Characteristics.

The open water area to be filled near the Kiwanis nature island has been proposed by the Kiwanis to be part of a larger recreation area on the island itself. The construction of the levee to bisect the nature island and the adjacent levee will impact the future recreational use of the island since a smaller area can be utilized once the levee is constructed. The construction of the levee might decrease the potential recreational features originally proposed for the island and lagoons.

G. DETERMINATION OF CUMULATIVE EFFECTS ON THE AQUATIC ECOSYSTEM

The filling of 2.7-3.8 acres of open water and 1.4-2.3 acres of wetlands at the Birdland reach would have a very minor cumulative effect on floodwater storage within the Des Moines River system. The existing Birdland levee prevents most floodwaters from entering the area to be impacted, although the levee was breached during the very large flood of 1993. There are no expected differences to flood heights due to the 2.7-3.8-acre open water and 1.4-2.3 acre wetland placement areas because of the small impact area and the fact that the impacts are currently located behind an existing levee. The wetland impacts for the permanent wetland fill as well as for the removal of wetland vegetation within 0.2 acres of wetlands at Birdland and 1.2 acres at Central Place will be mitigated, although the on-site wetland impacts cumulatively decrease the overall wetland area that serve as refuges for wildlife located within the City of Des Moines since most of the wetland mitigation will occur outside of the City. In addition, the lagoon near the Kiwanis Island is currently one lagoon and it will be split into two smaller lagoons. This will impact the area available for fish and other aquatic species to migrate for various life stage requirements.

H. DETERMINATION OF SECONDARY EFFECTS ON THE AQUATIC ECOSYSTEM

There could be secondary impacts to the aquatic ecosystem through temporarily increased turbidity adjacent to the levee construction areas. In addition, construction of the levees within the open water areas may require that the lagoons be drawn down prior to material placement. This would harm any aquatic organisms residing within the lagoons until construction was completed and the normal water levels returned.

CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

FINDINGS OF COMPLIANCE OR NONCOMPLIANCE
WITH THE RESTRICTIONS ON PLACEMENT

1. This flood control project has been evaluated in accordance with the 404(b)(1) Guidelines, and is expected to comply with those guidelines. This project would involve the permanent filling of approximately 1.4 - 2.3 acres of emergent wetlands and 2.7-3.8 acres of open water, and the permanent degradation of approximately 1.4 acres of bottomland forest through clearing, grubbing and maintenance of a mowed condition at the Birdland and Central Place levee reaches.

2. Alternatives considered in addition to the preferred alternative were as follows:

Reach 1 Birdland Park
- No Action
- Birdland Alignment 1, Levees 100-, 250-, and 500-year
- Birdland Alignment 2, Levees 100- and 250-year
- Birdland Alignment 3, Levees 100-, 250-, and 500-year

Reach 2 Central Place
- No Action
- Levees 100- and 250-year

Reach 3 Downtown East
- No Action
- Raise existing 100-year levee to 500 year level of protection

Reach 4 Downtown West
- No Action
- Raise existing 100-year levee to 500 year level of protection

Reach 5 Downtown South
- No Action
- Raise existing 100-year levee to 500 year level of protection

3. Certification under Section 401 of the Clean Water Act would be obtained from the State of Iowa prior to implementation.

4. The project would not introduce hazardous or toxic substances into the waters of the United States nor result in appreciable increases in existing levels of toxic materials.

5. No significant adverse impact to state or federally listed threatened or endangered species is anticipated from this project.

6. No municipal or private water supplies would be affected.

7. The permanent filling of approximately 4.1 to 6.1 acres of wetlands and open water is not considered to have significant environmental impacts, although it will have adverse environmental effects, both separately and cumulatively.

8. Approximately 2.8 to 4.6 acres of emergent wetlands will be created, 2.7 to 3.8 acres of open water will be created and 2.6 acres of bottomland forest will be enhanced to offset the loss of the 1.4 to 2.3 acres of emergent wetland loss, 2.7 to 3.8 acres of permanent open water loss, and 1.4 acres of bottomland forest losses from levee construction. Mitigation acreages will increase proportionally as needed to ensure adequate compensation for project impacts.

7 Sep 05
(Date)

for DUANE P. GAPINSKI
Colonel, U.S. Army
District Engineer

DES MOINES/RACCOON RIVERS FEASIBILITY REPORT
DES MOINES/RACCOON RIVERS STUDY
POLK COUNTY, IOWA

APPENDIX J

GEOTECHNICAL

FEASIBILITY/DEFINITE PROJECT REPORT FOR FLOOD CONTROL PROJECT DES MOINES AND RACCOON RIVERS CENTRAL PLACE LEVEE, POLK CO., IOWA

APPENDIX J
GEOTECHNICAL

PREPARED BY:
DONALD H. BAWMANN
GEOTECHNICAL BRANCH

SEPTEMBER 2002

FEASIBILITY/DEFINITE PROJECT REPORT
FOR
FLOOD CONTROL PROJECT
DES MOINES AND RACCOON RIVERS
CENTRAL PLACE LEVEE, POLK CO., IOWA

APPENDIX J
GEOTECHNICAL

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ATTACHMENTS

1 Packet of geotechnical information containing drill boring logs, laboratory testing results, and subsurface profile obtained and presented by Terracon Consultants of Des Moines, Iowa under contract with the U.S. Army Engineer District, Rock Island in May-June 2002.

2 Memorandum thru ED-G for ED-DM dated 28 May 2002 entitled "Geotechnical Engineering Conditional Probability of Failure for Existing Levees at Central Place Levees (Des Moines, Iowa Feasibility Study)"

PURPOSE

The purpose for this geotechnical study is to present both historical and current exploratory drilling and laboratory testing findings used to establish various study analyses parameters of which the results were used to support document decisions made herein.

PHYSIOGRAPHY

The project, which presently incorporates an existing levee system constructed by the City of Des Moines over a period of many years, lies entirely within the flood plain of the Des Moines and Raccoon Rivers. A site plan of this arena is shown on plate J-1. The upper alluvial stratum consists of clay varying in thickness from 3 to 15 feet which is underlain by both alluvial and glacial-fluvial sands. Bedrock lies at depths as great as 40 feet below the ground surface. Industrial and urban operations cover the natural deposits in many areas. These levees have been subjected to floods in the past, where tied to high ground, sustained the head without serious distress for the most part. The site is situated in Polk County on the right bank of the Des Moines River.

The valleys of the Raccoon River, the Des Moines River downstream from Des Moines, and Beaver Creek upstream from Des Moines are believed to have begun their development during the Aftonian interglacial period. At that time the main drainage from the north passed a few miles east of the city of Des Moines. Subsequent glacial action resulted in development of the relatively new and shallow valley of the Des Moines River through the city. The Mankato lobe of Wisconsin glaciations reached approximately to the Raccoon River, and is believed to have had little effect on the drainage pattern in the proposed area.

The bedrock in the vicinity of Des Moines is of the Des Moines Series of the Pennsylvanian System. The stratigraphy of the area was deposited in a deltaic transgressive-regressive environment, which left cyclic layers of both marine and terrestrial materials that consist of massive layers of shale's of varying lithology, interbedded with sandstones, limestone's and coals. The shale's range from relatively tough, compact clay shale's, to weaker silty mud shale's. The regional dip of the beds is gently to the southwest; although locally they may be more steeply inclined. These rocks, comprise a total thickness of more than 200 feet in some locations. Coal mining, of considerable importance some 80 to 90 years ago, is not of significance in the area at the present time nor is it expected to become so in the future.

SUBSURFACE EXPLORATIONS

The exploration program for this project was accomplished during two, substantially different, time periods. The intended purpose of the program was to define areas of generalized soil conditions, define specific areas of concern for structures, and acquire quality soils information necessary to conduct technical studies pertinent to underseepage, slope stability, and settlement. Locations of all borings obtained by both manual and mechanical methods are shown on Boring Locations, plate J-2.

The first series of borings were taken by the Corps of Engineers Geotechnical Branch in conjunction with the General Design Memorandum for the Des Moines River at Des Moines, Iowa Local Flood Protection study. The study was completed in February 1963. The purpose of the borings was to accomplish the initial geotechnical site investigation for this project. The borings for this series were taken by manual methods in April and October of 1962 as shown on Boring Logs I, plate J-3. The manual methods employed utilized a 4-inch diameter Iwan-type hand auger to obtain soil samples.

The second series of borings were taken under contract with Terracon Consultants of Des Moines, Iowa in conjunction with the present 2002 Des Moines and Raccoon Rivers Feasibility Study. A detailed exploratory drilling program, stating location and termination depth for each boring, was outlined in the drilling contract. Seven of the nine borings were selected to be drilled along the proposed alignment. The remaining two were to be drilled in the proposed adjacent borrow site. The borings for this series were taken by mechanical methods in May of 2002 as shown on Boring Logs II, plate J-4. The borings were drilled using both a truck-mounted and an all-terrain vehicle (ATV) rotary drill rig using continuous flight hollow-stemmed augers to advance the boreholes. Field logs of each borehole were prepared by the drill crew. The field logs contained visual classifications of materials and interpretive changes in subsurface conditions between samples. These borings were taken to fill in the gaps left by the 1962 exploration program and to determine the type and extent of the pervious aquifer and bedrock.

All 2002 mechanical borings were initially located and laid-out on-site, paying attention to specific reaches of uniform ground conditions and to those reaches that might be cause for levee distress concerns. Existing overhead power lines and access to the drill site was also viewed with precautions in mind. Available operating and construction space was viewed in relation to the structure selection.

The existing riverbank was inspected for existing stone protection, extruding pipes, and erosional distress. Proposed locations of the exploratory borings were plotted on topographic mapping for ease of location by the Contractor.

The site investigations determined that levee construction was feasible along the proposed alignment and offered no substantial restrictions or obstructions to provide this type of flood control protection.

Isolated observations of on-going levee distress was documented during the investigation and revealed that the existing riverbank was eroding in various areas from previous high river flows. This condition lends concern to the existing levee conditions and the engineering judgment that will determine what should be done in the way of tree removal and placement of riverbank and/or riverside slope stone protection.

During the study, any pertinent exploratory information along and adjacent to the proposed alignment, was obtained from available sources. This included the Iowa State Highway Commission, who was tasked with furnishing the numerous exploratory borings obtained for the freeway system over the Des Moines River in 1962.

Exploration data from existing remote borrow sites was not addressed at this time, due to the potential of acquiring suitable borrow materials on-site.

The exploratory drilling program was divided into two specific groups; "levee" and "borrow". "Levee" borings were obtained by both mechanical and manual methods. Mechanical drill borings, taken in 2002, were taken through the existing miscellaneous levee embankment fill, impervious top stratum clay, and pervious substratum sand, into bedrock. Boring locations for the mechanical borings were strategically placed along the levee alignment to provide a complete geologic profile of subsurface soils and bedrock. Mechanical borings were terminated in bedrock for the purpose of obtaining sufficient visual classification and testing results to perform underseepage, settlement, and slope stability studies. Depths of these mechanical levee borings ranged from 34 to 49 feet. Hollow-stemmed auguring was used to advance the boreholes and split spoon sampling was employed to penetrate the bedrock shale. Manual hand auger borings, taken in 1962, were taken through the existing levee embankment fill at centerline and through the impervious top stratum clay into the pervious substratum sand both landside and riverside of the existing levee embankment. "Borrow" borings were taken mechanically in 2002 through the impervious top stratum clay for the purpose of determining if suitable quantities of impervious borrow

was available. Depths of these borings were advanced to 13 feet. No specific structure borings, necessary for gate wells and pump stations, were obtained at this time.

Both standard split spoon (2-inch O.D.) and thin-walled tube (2-inch O.D.) sampling methods were employed to obtain jar samples at every 2.5-foot interval depth through the existing miscellaneous levee embankment fill and impervious top stratum clay, 2.5-foot and 5-foot interval depth through the pervious substratum sand, and 2.5-foot interval depth into the bedrock (shale). All samples and cores were transported to the Terracon laboratory for classification and testing.

An automatic SPT hammer was used to advance the split-barrel sampler to obtain standard "N" penetration (blows per foot of a 140-pound hammer falling 30 inches on a 2-inch O.D. split spoon) at interval depths in the soil types mentioned herein. Blow counts were recorded at each 6-inch interval of depth. This value is used to estimate the in-situ relative density of cohesionless soils and the consistency of cohesive soils. It should be noted that a greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with cathead and rope and has an appreciable affect on the N values.

A thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the ground to obtain relative undisturbed samples of cohesive soils.

SOIL TESTS

Laboratory soil testing of the samples obtained in 1962 was performed by CEMVR-ED-G whereas the 2002 samples tested was performed by Terracon Consultants laboratory in Des Moines, Iowa. Terracon prepared final boring logs relative to the field logs and laboratory observations and tests.

A selected number of pocket penetrometer tests were recorded in both the existing miscellaneous levee embankment fill and the impervious top stratum clay where thin-walled tube samples were inadequate for unconfined compression tests. Pocket penetrometer tests are recorded in pounds per square foot (psf). The hand penetrometer device has been correlated with the laboratory unconfined compressive strength to provide an estimate of the strength and consistency of the soil sample.

Unconfined compressive (UC) strength, dry unit weight (γ_{dry}), moisture content, and Atterberg limits tests were performed on suitable cohesive samples of the embankment and top stratum. The UC tests were recorded in psf. The γ_{dry} tests were recorded in pcf (pounds per cubic foot).

Two standard Proctor tests were run. The first on a standard bulk sample comprised of a mixture of impervious top stratum native soils from the borrow site. The second on a bulk sample comprised of a mixture of impervious fill soils from the existing levee embankment. Atterberg limits, minus number 200 wash, and specific gravity tests were obtained for both Proctor tests. The purpose for these tests were to determine the suitability of the soils for use as fill for construction of a new compacted impervious fill embankment.

Visual classifications, based on visual observation, texture, and plasticity, were performed in accordance with the Unified Soil Classification System (USCS) on each soil sample in the field and again, more precisely, in the testing laboratory. Natural moisture content was determined on all soils samples, impervious and pervious. Atterberg limit tests and washed gradation analyses were performed on selected soil samples. Results of the Atterberg limits are plotted on the plasticity chart shown on plate J-5. Numerous minus No. 200 sieve wash tests and wash gradation tests were performed on representative samples of the top stratum and substratum. Effective grain size (D_{10}) and percent passing the No. 200 sieve was determined for each gradation and wash test, respectively. Gradation curves are shown in Attachment 1. Visual laboratory classifications, blow count recordings for standard split spoon penetration and pocket penetrometer tests, and indicated values for natural moisture content, Atterberg limits, minus No. 200 sieve wash, effective grain size (D_{10}), unconfined compressive strength, and dry unit weight are shown in Attachment 1 and plate J-4 entitled Boring Logs II. Unconfined compression testing was selected in lieu of undisturbed shear strength testing for the purpose of acquiring a greater number of strength tests.

PROBABILITY OF FAILURE FOR EXISTING EMBANKMENTS

The existing levees along the proposed Central Place alignment are at present providing flood protection for the City of Des Moines, Iowa. These levees were built by the City in the early 1950's for this purpose. The levees were constructed without the provision of seepage cutoff trenches. Random fill from a local construction project was used to construct the levees. No reported compaction requirements were used during construction. Improvements to these levees, in the form of enlarging and heightening, have taken place since this time period. For the most part, the existing levee embankments are generally composed of CL sandy lean clay in conformance with the Unified Soil Classification System. However, there is overwhelming evidence that the embankment fill also contains various

unknown quantities of miscellaneous fill in the form of concrete rubble, fragments of brick and bedrock shale, asphalt, gravel, and pockets of sand. In addition, it was noted during onsite inspection that concrete and tire debris is piled against the levee. The discovery of uncovering these components during the exploratory drilling program lends questionable concerns of just what quantities and extent of these unsuitable components lie within the existing embankments. It is these components, left unattended to, that in time lead to levee distress problems during high water events.

Site inspections conducted in 2002 revealed that maintenance to these levees has been extremely limited for the most part. Only the vegetated crown portion of the levee appears to be reasonably well maintained. There is an extreme overgrowth of trees within the existing levee embankment. Many of these trees are quite large in size and have been present for years, establishing extensive root systems that penetrate the embankment structure. There is extensive erosion into the levee embankment already in evidence. The tree roots provide exceptional opportunity for high river waters to seep along them until well established seepage flow paths are formed and eventually begin to pipe embankment materials along them. Trees along the waterside of the levee lend cause to scour and erosion of the overly steep riverside embankment slope. This is due mostly to lack of vegetation, resulting from the inability to mow and maintain vegetation on the slopes, to prevent this. In addition, the trees have potential to topple onto the crown of the levee during high winds when the levels of the river are high, near the top of levee. Burrowing activity by rodents and other burrowing animals, prevalent along these existing levees, lends cause for loss of levee embankment material and attraction for flow paths of through seepage. A large isolated soft area was discovered embedded in the existing crown of the levee of which resulting explorations uncovered the cause. High water events have exposed other documented concerns for the existing levee embankment, i.e., boils, sponginess, and soft spots at the landside toe, poor embankment conditions around pump station discharge pipes, and scour attacking some areas on the riverside slope of the levee. Beyond this, there is the presence of aging utilities, pipes, and pump stations, in addition to portions of the underlying embankment that may contain cut-off tree stumps not removed during post 1993 improvements. Other concerns of probability within the existing embankment are landfill dumping, old appliances, construction rubble/debris, and common household-type garbage.

In general, the existing conditions of these levees offer suspense as to their present integrity. This and the knowledge of unknown quantities of unsuitable materials leaves questionable concerns for the final decision of which

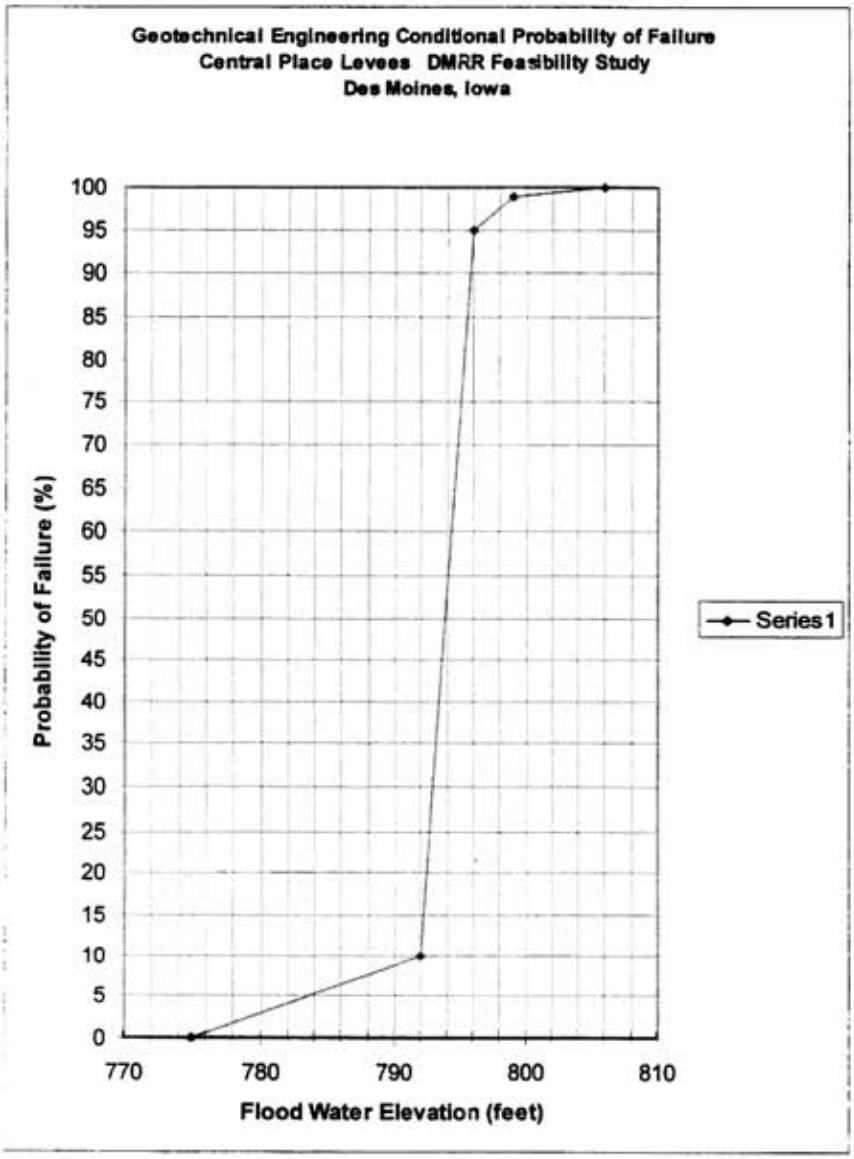
method will be selected to improve the existing levee embankment to a safe, long-lasting structure of integrity. These existing levee embankment issues and the risk-based analysis guidance selected for this study are discussed at length in the memorandum entitled "geotechnical engineering conditional probability of failure for existing levees" as shown in Attachment 2.

In summary, based upon visual observations, findings, and performance both during and following the historical flood of 1993, a failure analysis table was created (shown below) stating the percent probability of failure to flood water elevation in both NGVD elevation and City of Des Moines datum.

FAILURE ANALYSIS TABLE

Flood Water Elevation in City of Des Moines Datum (NGVD) (feet)	Percent Probability of Failure	Description of Elevation
1 (775)	0	Invert of storm sewer system near levee
18 (792)	10	Riverside ground level
22 (796)	95	Landside ground level at landside toe of levee
25 (799)	99	Average base elevation of existing levee
32 (806)	100	Selected average top elevation of existing levee

A chart (shown below) depicts this table.



The flood water elevation of 796 NGVD (22 City of Des Moines Datum) is hereby selected as the determining flood water elevation. This elevation is indicated to be the natural ground level at the landside toe of the levee, based upon last years (2001) levee embankment cross-sections,

surveyed by City of Des Moines personnel. In conclusion, when flood water falls below this elevation, a significant reduction in probability of failure occurs. When flood water rises above this elevation, a rapid increase to failure certainty occurs.

PROPOSED EMBANKMENTS

The "first-considered" method of construction would be to: remove the existing levee embankments, excavate an inspection trench throughout, and construct new levee embankments. Appropriate placement and compaction standards would be exercised to reuse as much of the suitable re-claimed existing levee embankment impervious materials as is available. Adjacent on-site borrow would be used to complete the needed quantities. At the present time, inspection trenches beneath these existing levees are non-existent. Subsurface impervious top stratum soils beneath these existing levees appear suitable for support of the levee embankment structure. For the most part, the knowledge and location of all buried pipes has been pre-determined. However, any unknown pipes or unsuitable materials not yet revealed will be uncovered during excavation of the inspection trench.

The "second-considered" method of construction would be to: remove all trees on the riverside face of the existing levee embankment, uncover and repack rodent and burrowing animal holes and tree root damage, cut benches in the existing riverside embankment face, and re-face the riverside slope of the existing levee embankment by constructing a new impervious clay riverside face. This mode of construction would be necessary to tie and bond the new impervious face into the existing levee embankment. Placement of materials would require a horizontal width of some 15 feet, or a nominal thickness of 5 feet. This sizing would be implemented to accommodate modern earth moving equipment on the 1 vertical on 3 horizontal slope.

The "selected" method of construction for this flood protection project will be to construct a composite levee embankment section from Station 16+00 to 68+69. The section will be composed of a clay-fill riverside face bonded into the remaining existing levee. The anticipated re-use of an overabundant supply of on-site existing impervious embankment fill materials will be used to construct the majority of the new clay face. Additional borrow, if needed, will be removed from a nearby impervious clay borrow site and hauled to the construction site. Re-usable soils from the existing levee embankments will be excavated, moved and placed by scrapers in prepared areas of construction. The materials will then be mixed and spread by bulldozers. Upon proper mixing and preparation of the soils, the clay

face will be constructed by compacted impervious fill requirement methods to oblige any less than optimum moisture content fill soils. The recommended slopes will be constructed to 1V on 3H, both riverside and landside, to harmonize urban space limitations and to provide stability to the structure. The crown of this levee will have a minimum width of 15 feet to provide a nominal thickness of 5 feet and to serve normal maintenance and emergency flood-fighting operations. The embankment crown and side slopes will be heavily seeded to encourage vegetation growth, which can be mowed easily. The "first-considered" levee embankment section is as shown on plate J-6. The "second-considered" and "selected" levee embankment section is as shown on plate CP9.

An inspection (exploration) trench will be excavated under all levees. A conventional approach will be implemented throughout the project. Trench dimensions will incorporate 1V on 1H side slopes, 6 feet in depth with an 8-foot bottom width. Innovative methods, such as excavation of a narrow, vertical trench, are not considered to be effective for inspection during construction in this urban environment. The standard inspection trench will be located at the riverside toe of the existing levee. Where subsurface conditions consist entirely of impervious and semi-impervious top stratum native alluvium, the inspection trench will be backfilled with impervious material. Where subsurface conditions consist of relatively semi-impervious top stratum and expose the pervious substratum, the inspection trench will also be backfilled with impervious material. Where subsurface conditions expose the presence of rubble fill, on-site inspection will determine the suitability of the materials. If deemed unsuitable, the materials will be removed and wasted and the inspection trenches will be backfilled with impervious material. Design concept of this trench is also shown on the typical new levee section, plate CP9.

The geologic profile, shown on Geologic Profile I and Geologic Profile II, plates J-7 & J-8, reveals that the new levee embankments will be raised to heights of from 4 to 13 feet. This raise is no more than 2 feet above the present existing levee height. Some adjustments to these heights may be revealed in isolated areas. Ground surface irregularities beneath the structure will be filled and compacted with impervious material. Depressions and sloughs landward of the embankments will be filled with sand up to the natural ground surface for 100 feet beyond the levee toe or berm. Excess suitable fill removed from the existing levees will also be used as depression fill. This scheme will be used to establish ground surface uniformity and prevent the occurrence of unrestricted underseepage.

The clay face of the levee embankments will be constructed entirely of impervious fill materials. Most of the impervious fill materials will come from removal of the existing levee embankments. Additional impervious fill materials, if needed, will come from an on-site borrow area. Impervious fill materials from the existing levee embankments are generally similar and are classified as CL sandy lean clay, trace gravel. On-site borrow materials reveal the same classification, CL sandy lean clay. Moisture control for the impervious fill will be monitored by on-site construction inspection. The moisture contents for the impervious fill materials from the existing levee embankments appear to be near optimum moisture content whereas materials from the on-site borrow area reveal more than 10 percent over the optimum moisture content. A deviation of no more than 2 percent dry and 2 percent wet of optimum moisture content will be desired (not required) for all impervious fill materials. Natural moisture contents of the existing levee fill ranges from 10 to 29 percent whereas the on-site borrow fill ranges from 26 to 28 percent. Mixing of the soils, particularly the existing levee fill, will be required to promote a uniform fill for placement, conditioning, and compaction. It is anticipated the mixing of the soils will retain the soils natural moisture content around the optimum moisture content and not require conditioning prior to placement. The standard Proctor curve and moisture control evaluation summary for both the existing levee embankment and borrow site soils are shown on plates J-9 & J-10 and J-11 & J-12, respectively. The moisture control evaluation summary discloses the allowable and selected deviation from optimum moisture content for the CL soil types.

Construction of the embankment will be by "end result" methods, controlled in two ways. First, the thickness of impervious layers before compaction (unless otherwise directed, i.e., 12 inches for rubber-tired rollers) shall be not more than 8 inches in depth. Second, each lift of impervious material shall be compacted to not less than 95 percent of maximum dry density, standard Proctor, ASTM D 698, at plus or minus 2 percent of optimum moisture content. Both tamping-type (tractor-drawn and self-propelled) rollers and rubber-tired rollers will be specified to accomplish this requirement. Either tractor-drawn and/or self-propelled tamping rollers will be permissible.

Both contractor quality control (CQC) and government quality assurance (GQA) testing will serve to assure that required maximum dry density is achieved during construction. During initial embankment construction operations, the designated rate of testing for CQC will be 1 field in-place density test (ASTM-D 1556 sand cone and/or ASTM-D 2167 rubber balloon) for every 1,500 cubic yards of fill placed or a minimum rate of at least 1 test per day. GQA testing will

supplement these requirements at a rate deemed necessary. This scheme shall be used until the construction operation can be rated successful to accomplish the proposed requirements. Upon a successful rating, testing during embankment construction operations will be reduced to 1 field in-place density test for every 10,000 cubic yards of fill placed (minimum 1 test per day during embankment placement).

As a supplement to the standard tests stated, the contractor (with caution) will be allowed to use a "nuclear" device conforming to ASTM-D 2922 standards for "density only". However, the devices use as a "moisture" content supplement conforming to ASTM-D 3017 standards is "discouraged" without sufficient and regular moisture content correlation tests. The nuclear device data will "not" be allowed to supplement required standard testing data.

Moisture control should not pose a problem for the existing levee fill since natural moisture contents are near optimum moisture content. However, any use of borrow site soils will undoubtedly require drying back before compaction. Any materials encountered that become too wet or too dry for proper compaction will require that the contractor either dry-back or pre-wet the material prior to rolling operations.

FOUNDATIONS FOR EMBANKMENTS

The entire foundation beneath the new levee embankments will be cleared, grubbed, and stripped to remove unsuitable matter. Inspection trenches will be mandatory beneath all levee embankments. Trenches will be located at or near the centerline of the proposed embankment. For the most part, trench excavations are not expected to penetrate normal groundwater levels. Standard inspection trenches for the new levees will be 8 feet wide to accommodate modern earth-moving construction equipment. For embankment heights greater than 6 feet, the trenches will be extended to a maximum depth of 6 feet to unveil any significant underground features such as pipes or unsuitable materials. Unsuitable materials will be penetrated to preclude the possible occurrence of serious shallow seepage. Any soft foundation materials encountered within the levee foundation extremities, at or near the surface, will be excavated and removed. For embankments less than 6 feet in height, the trenches will extend to a maximum depth equal to the embankment height. Side slopes for the trenches will be 1V on 1H. The trenches will be backfilled with impervious fill and compacted to embankment standards. In areas where existing rubble fill is encountered and where onsite inspection and evaluation deems the rubble fill unsuitable for embankment support, excavations for inspection trenches

will be expanded. These trenches will extend through the rubble fill at a slope of 1V on 3H to at least 1-foot into the underlying impervious top stratum, if existing. This scheme will provide a positive cutoff (impervious barrier) to prevent the potential occurrence of shallow seepage through the rubble fill.

In rubble fill areas deemed unsuitable for embankment support, standard inspection trenches will be expanded to incorporate various schemes to compliment the variable thickness. Where the rubble fill areas are 5 feet or less in thickness, excavation will encompass the entire base width of the levee. Excavated rubble fill will be wasted. Beneath the embankment, the excavation will be backfilled with compacted impervious fill both inside and outside the structure template. Design concepts pertinent to these subsurface conditions are not shown herein. Typical levee sections depicting these design concepts will be shown in plans and specifications should further explorations indicate the need to do so.

Boring logs indicated that the natural top stratum is composed primarily of impervious alluvium (SC, CL, CL-CH, and CH soils). In one case, a thin strata of ML soils (possibly not a native deposit) was uncovered. The impervious alluvium varies in extent from 2 to 15 feet beneath the natural ground surface as shown on plate J-13. Moisture contents of the impervious alluvium top stratum ranges from 15 to 31 percent for CL soils, 18 to 28 percent for CL sandy soils, 15 to 21 percent for SC soils, 23 to 36 percent for CL-CH soils, 29 to 57 percent for CH soils, 19 percent for ML soils and Atterberg limits for these soils are shown on plates J-14 thru J-17. Except for one isolated case in bore hole D-4, Atterberg limits and moisture content indicates that no exceptionally weak or sensitive soils were encountered and that shear strength is high. Standard penetration tests of the impervious alluvium range from 3 to 6 for CL soils and 2 to 4 for CL/SC sandy soils, indicating a soft to medium stiff consistency. Both recent and former bore holes reveal the groundwater is confined within the boundaries of the impervious top stratum. Recordings obtained in 1962 and 2002 indicated the groundwater levels to vary from 1-foot above to 11 feet below the existing ground surface.

Undisturbed shear strength correlation curves plotting cohesive shear strength versus water content for CL, CL-CH, CH, SC, and ML soils are shown on plates J-18 thru J-23. The curves were developed from unconsolidated-undrained quick triaxial and unconfined compression tests performed by Missouri River Division and supplied by the Rock Island District. These curves are considered applicable to the Central Place alluvial soils. A summary plot of these soils is shown on plate J-18. The CL soils curve indicates a

range in cohesion from 400 to 850 pounds per square foot (psf) with moisture contents varying from 15 to 31 percent as shown on plate J-19. The CL sandy soils curve indicates a range in cohesion from 450 to 700 psf with moisture contents varying from 18 to 28 percent as shown on plate J-19. The CL-CH soils curve indicates a range in cohesion from 410 to more than 1000 psf, with moisture contents varying from 23 to 36 percent as shown on plate J-20. The CH soils curve indicates a range in cohesion from 410 to more than 1000 psf, with moisture contents varying from 29 to 57 percent as shown on plate J-21. The SC soils range from 450 to 700 psf with moisture contents varying from 15 to 21 percent as shown on plate J-22. The ML soils exceed 1000 psf with a moisture content of 19 percent as shown on plate J-23.

Unconfined compressive strength (UC) and unit weight tests were selected to be performed on the relative undisturbed samples of suitable cohesive and moderately cohesive impervious alluvium top stratum soils. UC strengths are reported in pounds per square foot (psf) whereas dry unit weights are reported in pounds per cubic foot (pcf). Testing of the samples, selected by the designated Terracon Project Engineer, was conducted in the Terracon testing laboratory. The samples were obtained during the exploration program. Each thin-walled tube sample was examined in the laboratory for quality and suitability prior to selection for testing. A tabular summary of the unconfined compression strengths and unit weights are as shown on plates J-14 thru J-17. This summary also includes the classification, Atterberg limits, and natural moisture content for each test sample. Conversion of these strengths to undrained shear strengths was determined by assuming that the undrained shear strength is equal to one-half the unconfined compressive strength. It should be noted however that the UC test is not considered a direct substitute for the unconsolidated-undrained test (commonly called Q-test) since a confining pressure is not applied during loading of the test specimen. In the UC test, the cylindrical specimen is laterally unsupported during application of a gradual increase in axial compression load until failure occurs.

Hand penetrometer tests were performed also on the relative undisturbed samples of cohesive and moderately cohesive impervious alluvium top stratum soils obtained during the exploration program. This was done in the laboratory to determine an estimate of the strength and consistency of the soils sample. The hand penetrometer device has been correlated with the laboratory UC strength. Readings revealed the unconfined compressive strength of the soils in pounds per square foot (psf). A tabular summary of these unconfined compression strengths are as shown on plates J-14 thru J-17.

The pervious substratum (commonly termed pervious aquifer) lies directly beneath the impervious top stratum and consists of SP, SP-SM, SW-SM, and SM soils. The entire pervious substratum was penetrated mechanically to and into bedrock shale in every drill boring. Standard penetration tests (SPT) were obtained by Terracon and ranged from 2 to 40 blows per foot (bpf), indicating an overall loose to dense relative density. Breaking down the classifications in the pervious aquifer, the SP soils ranged from 6 to 8 bpf indicating a loose relative density, the SP-SM soils ranged from 14 to 22 bpf indicating a medium dense relative density, the SW-SM soils ranged from 10 to 40 bpf indicating a medium dense to dense relative density, and the SM soils ranged from 2 to 27 bpf indicating a loose to medium dense relative density as shown on plate J-24. Logs of borings reveal these values as shown on Boring Logs II, plate J-4. The pervious substratum contains both alluvial and glacial-fluvial sands that are relatively dirty. Laboratory testing revealed the fines to be predominately silt. The silt fines varied from 3 to 44 percent passing the No. 200 sieve. The depth of the pervious aquifer varies from 7 to 30 feet. Gradation tests reveal the effective grain size (D_{10}) for the SP, SP-SM, SW-SM, and SM soils ranges from 0.08 to 0.18 mm overall with one isolated case at 0.29 as shown on plate J-25. The coefficient of permeability (k_h) ranges from 0.01 to 0.08 centimeters per second with one isolated case at 0.18 as shown on plate J-25.

The Des Moines series bedrock formation is of the Pennsylvanian system and ranges from elevations 759 to 774 feet (NGVD 1929 datum) or -14.8 to +0.2 (City of Des Moines datum). Bedrock encountered was shale. The bedrock was penetrated by a standard split barrel sampler. Standard penetration tests of 50 blows varied from 0.2 to 1.0 feet (2 to 12 inches) of penetration indicate the shale to be moderately hard as shown on plate J-26.

FOUNDATION FOR OTHER STRUCTURES

Foundation materials encountered during exploratory operations revealed a variety of classifications as shown on Boring Logs I and Boring Logs II, plates J-3 and J-4. Unsuitable materials such as rubble fill and/or soft alluvium soils, encountered at site specific structure locations, will be removed and replaced with suitable materials. The replacement materials will be compacted properly to obtain densities equal to or greater than adjacent undisturbed foundation material. Suitable materials encountered were determined from field and laboratory examination. In the field, material suitability as structural support was determined during exploratory operations by correlating consistency and relative density with standard penetration tests. In the laboratory,

material suitability as structural support was determined for the impervious top stratum soils by correlating cohesive shear strength for the impervious top stratum soils with moisture content tests, unconfined compression strength tests, hand penetrometer tests, dry unit weight tests, moisture contents, and Atterberg limits tests, and from standard penetration and relative density and effective grain size and relative coefficient of permeability for pervious substratum soils. Reference to these results is tabulated on plates J-14 thru J-17, J-24, and J-25, for each exploratory boring relative to proposed specific structures and their location.

Existing subsurface soils at the Second Avenue pump station (station 16+00) (reference borings 28A and D-2, Boring Logs I and Boring Logs II, plates J-3 and J-4) indicates suitable support for the structure. The impervious top stratum CL and SC soils, some 15 feet in thickness (elevation 797 to 782) indicates medium stiff to stiff consistency with indicated cohesive shear strength ranging from 500 to 700 psf. Underlying this, a stratum of SM and SW-SM soils, classified as silty sand to silty medium to fine sand with a relative density of loose to dense, extends to the top of a moderately hard bedrock shale (elevation 759). The loose portion of the stratum was found to extend some 8 feet in the SM soils, lying directly beneath the water table. It should be noted that it is not uncommon for loose sand to be detected in the initial split-barrel sample beneath water table. Limited penetration of the moderately hard bedrock shale was induced to verify its existence.

Existing subsurface soils at the Franklin Avenue pump station (station 23+48) (reference borings D-2 and 28/26, Boring Logs I and Boring Logs II, plates J-3 and J-4) indicates suitable support for the structure. The impervious top stratum CL and SC soils, some 9 to 13 feet in thickness (elevation 796 to 783) indicates medium stiff to stiff consistency with indicated cohesive shear strength ranging from 500 to 700 psf. Underlying this, a stratum of SM and SW-SM soils, classified as silty sand to silty medium to fine sand with a relative density of loose to dense, extends to the top of a moderately hard bedrock shale (elevation 759). The loose portion of the stratum was found to extend some 8 feet in the SM soils, lying directly beneath the water table. A nearby boring, obtained in 1962 by hand methods, indicates the pervious stratum may contain SP gravelly coarse to fine sand with an unknown relative density. Limited penetration of the moderately hard bedrock shale was induced to verify its existence.

Existing subsurface soils at the Clark Street pump station (station 48+57) (reference boring D-5, Boring Logs II, plate J-4) indicates suitable support for the structure. The impervious top stratum CL soils, some 6 to 7 feet in

thickness (elevation 788 to 781) indicates soft to medium stiff consistency with indicated cohesive shear strength ranging from 450 to 500 psf with a possible low of 250 psf. Underlying this, a 7-foot stratum of SP-SM soils, classified as silty medium to fine sand with a relative density of medium dense, extends to the top of a moderately hard bedrock shale (elevation 774). Limited penetration of the moderately hard bedrock shale was induced to verify its existence.

Existing subsurface soils at the Indiana Avenue pump station (station 62+16) (reference borings 35/34 and D-6, Boring Logs I and Boring Logs II, plates J-3 and J-4) indicates suitable support for the structure. The impervious top stratum CL, CL-CH, and SC soils, some 6 to 9 feet in thickness (788 to 779) indicates soft to medium stiff consistency with indicated cohesive shear strength ranging from 400 to 1000 psf. Underlying this, a 9-foot stratum of SP-SM and SW-SM soils, classified as silty medium to fine sand, silty medium to fine sand with gravel, and silty gravelly coarse to medium sand with a relative density of medium dense, extends to the top of a moderately hard bedrock shale (elevation 770). Limited penetration of the moderately hard bedrock shale was induced to verify its existence.

SLOPE STABILITY

All levee embankment sections will be constructed of compacted impervious fill. The maximum embankment height is indicated to range from 7 to 13 feet. Prior to embankment construction, any reach of levee that encounters ground surface depressions and irregularities will be filled with impervious fill. The levee embankment section at station 42+00 was selected to be considered as the most critical with respect to the stability of the riverside and landside slopes. The section here is best represented by exploratory bore hole D-4, drilled by mechanical methods at station 41+95. The selected section was based on embankment height, steepness of slopes, and/or thickness and consistency of the impervious top stratum.

It should be emphasized that stability of embankment slopes will not be a factor in this area where miscellaneous rubble fill was encountered. It is planned to totally remove the unsuitable rubble fill discovered beneath the major portion of the proposed embankment. In addition, this scheme will also alleviate potential settlement to the structure.

The most critical section studied was represented by the riverward slope of the proposed new levee embankment at levee station 42+00, This study was conducted to insure the minimum factor of safety was satisfied. This section will

impose a height of about 12 feet. The side slopes, both riverside and landside, will be shaped to 1 vertical on 3 horizontal (1V on 3H). The crown will have a minimum width of 10 feet. Although the City has tentative plans to construct a pedestrian trail atop the levee, requiring a 15-foot crown width, the narrower 10-foot crown width was analyzed. The proposed new embankment will overly some 15 feet of impervious top stratum soils. The top stratum is made up of lean clay (CL soils) and fat clay (CH soils) containing traces of sand (reference boring D-4, Boring Logs II, plate J-4). As indicated in plates J-18 thru J-21, in-situ shear strengths for the CL and CH soils vary. This occurs dependent on which test method is selected to use. The cohesive shear strengths were determined in two ways. The first method considered was based on unconfined compression (UC) testing conducted for this project. The second method considered was based on individual soil-type curves derived from correlation of moisture content versus cohesive shear strength. For the CL soils, shear strengths ranged from 500 to 2300 psf for the UC tests and from 400 to 560 psf for the UU tests. For the CH soils, the shear strength varied from 500 psf for the UC test to 400 psf for the UU test. An average shear strength of 500 psf was selected for the CL soils based on 2/3 of the tests being above a value of 450 psf (UU tests) and 600 psf (UC tests). An average shear strength of 400 psf was selected for the CH soils. This was based on value of 400 psf (UU test) and 500 psf (hand penetrometer test). Examination of in-situ moisture contents and the unconfined compression tests of the impervious top stratum revealed this top stratum was the softest of this thickness relative to the greatest embankment height.

As mentioned herein, the shear strengths for the in-situ impervious top-stratum foundation soils were determined from undisturbed shear strength data. The data is a collection of numerous unconsolidated-undrained (quick strain) triaxial and unconfined compression tests of alluvial soils collected by the Rock Island District (RID) for Mississippi River alluvial soils in the district. The individual soil-type curves were developed from this data by Waterways Experiment Station (WES). Correlation curves for this data are shown for CL, CL-CH, and CH soils on plates J-19 thru J-21. For comparison purposes, the curves are shown together on plate J-18. Conservative values, relative to RID as-built shear strengths, were also selected for the strength of the proposed new embankments. Unit weights and shear strengths of both embankment and foundation at the most critical section were based on evaluated assumptions. These assumptions are shown on stability plates J-27 & J-28. Limited standard penetration and pocket penetrometer tests lend support to the shear strength selection.

Stability analyses were run in accordance with procedures in Engineer Manual 1110-2-1902, "Stability of Earth and Rock-Fill Dams", dated April 1970. The purpose of the analyses is to examine factors of safety for various embankment conditions to insure compliance with maximum safety standards. The circular arc analysis was determined to be the best suited method of analyzing the embankment stability. It is expected that the newly compacted soils will achieve and maintain for some duration of time, some excess pore water pressure. It is also anticipated that flooding will be of short duration. Historical records at 2nd Avenue for the past 45 years indicates the period of time that the river was at flood stage (796.8) and higher averages 1.9 days per year. This period of time is not considered a significant prolonged flood stage that would saturate a major portion of the riverside embankment. Due to this, the cases of sudden drawdown, partial pool, and steady seepage were not considered applicable for this study.

In the circular arc slope stability analyses, the elevation of the potential sliding surface was selected to be tangent to the "contact" of the impervious top stratum (CL and CH soils) overlying the pervious (foundation) substratum (SP-SM soils). In all analyses, the side earth force direction was assumed equal to the average of the embankment slopes immediately adjacent to the slice interface. A search routine was applied to find the critical failure surface having the minimum factor of safety. A number of trial circles, as shown on plates J-27 & J-29, were tried for this study condition before the minimum circular arc was determined. A summary of the individual stability analyses, including the plot and input/output data of the critical failure surface, is as shown on plates J-27 thru J-30.

The most critical section is represented at levee station 42+00 (reference boring D-4, Boring Logs II, plate J-4). This section was selected as the design condition to analyze for the end of construction condition riverside slope. Unconsolidated-undrained (Q) shear strength values were determined for each material type. A cohesion of 1000 psf and 7 degrees frictional angle was selected for the new CL sandy soils compacted impervious fill embankment extending from elevation 808 to 796. The selected shear strength was derived from previous triaxial compression tests performed for the Rock Island District on similar soils in the immediate area. Laboratory remolded strengths ranged from 820 psf and 1 degree to 5560 psf and 4.5 degrees. The impervious top stratum (impervious foundation) was composed of CL soils from elevation 796 to 782.5 atop CH soils from elevation 782.5 to 780.5, both containing a trace of sand. A cohesion of 500 psf with zero frictional angle and 400 psf with zero frictional angle was selected for the CL and CH soils, respectively. Groundwater surface was established to

be at elevation 784.5. The pervious substratum consists of SP-SM soils and extends from elevation 780.5 to hard bedrock shale elevation 773. Results of the analyses disclose the minimum factor of safety to be 2.65 with zero seismic force for the 1V on 3H riverside slope. This factor of safety exceeds the required minimum of 1.30. The analyses are shown on plate J-27. Configuration, soil constants and piezometric surface input data are shown on plate J-28. Trial search and selected minimum factors of safety are shown on plate J-29. Tabulation of slice data for the critical arc is shown on plates J-29 & J-30.

The critical failure surface shown herein was also analyzed using the UTEXAS4 program. Results indicated a factor of safety of 2.81 using the modified Swedish method and 3.18 using the Spencer method.

SETTLEMENT

The entire proposed new levee embankment, some 7,000 feet in lineal length, was examined for potential settlement considerations. The geologic profile, developed along the project alignment, confirms that the impervious top stratum is devoid of any land fill and varies from at least 2 to 15 feet in thickness. The top stratum materials vary from CH, CL-CH, CL, SC, and ML soils. A variation of additives is contained in the CL soils. The additives vary from "no sand", "trace sand", "with sand seams", "with sand", "with gravel", "sandy", to "sandy very lean". Boring D-4 (reference Boring Logs II, plate J-4) was selected to best represent a deposit of area soils conducive to settlement. The boring itself is located at Station 41+95 and indicates the thickest deposit (15 feet) of CL and CH soils anywhere on the alignment. At this location, the proposed 12-foot levee height will impose a maximum load of about 0.75 tons per square foot (tsf) on the 15-foot thick impervious top stratum blanket. It should be noted that of this proposed levee height, a portion (as much as 11 feet) of the proposed 12 feet has existed since the early 1950's. Field and laboratory tests indicate the CL soils to be relatively moist in nature with a medium stiff to very stiff consistency. The CH soil appears relatively moist to wet and is considered to have borderline consistency ranging from soft to medium stiff. Consideration was given to viewing this analysis as three (3) individual cases. Case I considered the entire top stratum of CL and CH soils to be normally consolidated. Case II considered that the upper 6 feet of the CL soils, above ground water level, to be over-consolidated whereas the remainder CL and CH soils to be normally consolidated. Case III considered the entire 13 feet thickness of CL soils, both above and below ground water level, to be over-consolidated whereas the remainder CH soils to be normally consolidated. A settlement analysis

for Case I conforming to Joseph E. Bowles "Foundation Analysis and Design," 3rd edition, 1982, formula 2.35, indicates total anticipated settlement to be in the order of 10.2 inches, as shown on plate J-31. A settlement analysis for Case II incorporating Braja M. Das "Principles of Foundation Engineering", 1984, indicates total settlement to be 6.4 inches (plate not presented). A settlement analysis for Case III indicates total settlement to be 3.8 inches (plate not presented). Based on the lack of documented history on the existing levee embankment height, and that anticipated settlement appears to range from 4 to 10 inches, a shrinkage allowance of at least 5 percent of the levee height will be provided in the specifications to allow for any consolidation of the embankment and settlement of the foundation.

It should be noted that no extremely soft clays were encountered throughout the project alignment. If soft clays are encountered during construction, these soils will be removed to prevent unwanted settlement.

THROUGH SEEPAGE

Through seepage will not be a factor for the new levee embankments constructed of compacted impervious fill. It is anticipated that the abundance of existing levee embankment fill soils will be used for this purpose. This fill, in general, is composed of sandy lean clay (CL soils). Small amounts of rubble fill, found included in this proposed construction fill, will be removed to the extent that the overall fill remains clean and impervious. Because of the flood duration not expected to exceed 1.9 days per year for the Des Moines River, a steady seepage condition is not anticipated to occur here.

UNDERSEEPAGE

Underseepage control measures for this project are based on a study of thickness and permeability characteristics of both the impervious top stratum and the pervious substratum and on the extent of the riverward and landward top stratum. The potential for underseepage is anticipated in the study area. If underseepage protection against uplift and piping is found to be necessary, control measures in the form of seepage berms will be provided. Seepage berms shall require free-draining sand with less than 5 percent passing the No. 200 sieve. If desired, six inches of top soil can be placed over the sand berm and seeded to encourage a healthy growth of grass in an urban area environment.

Criteria used in the underseepage and berm analysis conform to "Relief Well Design", Civil Works Engineer Bulletin 55-

11, dated 28 June 1955; Waterways Experiment Station Publication Technical Memorandum 3-424, "Investigation of Underseepage and its Control, Lower Mississippi River Levees", dated October 1956; and criteria contained in Engineer Manual 1110-2-1913, "Design and Construction of Levees", dated 30 April 2000.

The establishment of empirical limitations on such items as maximum length of berms and permeability ratios was constituted by the following two reports: "Report of Conference on Underseepage for Agricultural Levees" dated 11 October 1960 and "Tentative Criteria for Use of Underseepage Control Measures on Agricultural Levees" dated 3 June 1958. Both reports were prepared by the Rock Island District following a technical conference with North Central Division (NCD) and Office, Chief of Engineers (OCE).

A further modification of this criteria resulted from the "Minutes of Geotechnical Conference" held at Rock Island District on 29-30 April 1976. The methodology of the underseepage and berm analysis is the result of continuing documentation of performance of existing levees during high water periods in 1965 through 1975 from Dubuque, Iowa to Hamburg, Illinois by personnel of the Geotechnical Branch. This documentation has been supplemented by continued observations during high river periods through 2001. Methodology was further established in Supplement No. 1 to Design Memorandum No. 1 for Fulton, Illinois Local Flood Protection Project, Draft, December 1976.

Design input format and values used in determining the need for and the designing of seepage berms for levees are given in Summary of Underseepage and Berm Analysis plates J-32 & J-33. Transformed depth and permeability of the pervious substratum at locations relative to specific borings D-1 through D-7 are shown on plates J-34 thru J-37. Both landside and riverside top stratum blanket thick nesses were determined for specific designated reaches. All applicable borings were used for this determination. Engineering judgment was particularly exercised in reaches from Stations 10 to 15, 15 to 29, and 63 to 68 to determine these thick nesses where extensive thick nesses of SM soils were encountered. A plot of effective grain size (D_{10}) versus coefficient of permeability (k_h) used in the transformations of pervious substratum is shown on plate J-38. Vertical blanket permeability ratios were selected in accordance with the April 1976 conference. The factor of safety was computed from equation 9 on page 3 of Civil Works Engineering Bulletin 55-11. If the placement of a sand berm was considered, the thickness was computed for a factor of safety equal to 1.50 at the levee toe in accordance with the appropriate equation shown in Figure C-1 of EM 1110-2-1913. Reaches considered for sand berms are reflected by hold-down factor of safety against uplift at the landside toe of

levee. Levee construction on former projects indicates that the sand berm does not increase the head at the landside toe. This determination is based on piezometer readings and documented performances of sand berms since 1965. The berm length will be constructed in accordance with criteria developed in the Rock Island District for levees with sand berms at the April 1976 conference.

Input format and output results of the underseepage and berm analysis are shown on plates J-32 & J-33. The terminology reflecting the methodology established during the April 1976 conference is shown on plates J-39 thru J-42. A typical section for each levee reach, not shown herein, was drawn prior to each analysis to illustrate the subsurface profile developed from the pertinent borings.

A discussion of significant parameters for each specific reach of levee is not addressed herein. The data is self-explanatory as shown on the Summary of Underseepage and Berm Analysis (plates J-32 & J-33), the Typical Section (plate J-6), and the Terminology of Methodology (plates J-39 thru J-42). Sand berms were not found to be necessary in this study.

The amount of underseepage into the ponding area was conservatively assumed equal to the entire flow under the levees. The seepage beneath the levees was computed using a flood stage equal to the design levee grade and the estimated values of D, K_f, L_s and L_e for various reaches of the levee. The seepage flow (Q) per unit length of the levee was computed. Results of the study are shown on plate J-43. From the quantities indicated, it appears that the pumping capacities planned for this project will be adequate to control the ponding elevation for any infiltrating underseepage.

UNDERSEEPAGE CONTROL FOR PONDING AREA

Provisions to control underseepage and to prevent the formation of boils into the ponding area will be a primary concern at this project. Planned excavations will not be allowed inside 100 feet of the landside toe of the levee and/or berm. This scheme is considered beneficial in retaining an area sufficient in size to move equipment, laborers, and materials during periods of high river flows to accomplish a successful flood fight.

The proposed ponding area is located some 300 feet west of the Indiana Avenue pump station and in excess of 500 feet from the Des Moines River. The ponding area borders Forest Avenue on the north, Indiana Avenue on the south, Vermont Street on the east, and Ohio Street on the west. The primary purpose of the ponding area is to store interior

drainage in lieu of underseepage infiltration. At this site, it was determined by exploratory methods that the existing thickness of impervious top stratum CL soils is sandy and consistent in thickness from 2 to 2.5 feet. Atop this top stratum lie some 3 to 5.5 feet of rubble fill. Beneath this top stratum lies some 12 feet of pervious SP and SP-SM soils aquifer atop bedrock shale. Due to the limited amount of suitable impervious top stratum borrow soils at this site, it is uncertain whether any borrow excavation will be utilized from the ponding area. The existing impervious top stratum thickness and distance to the potential source of seepage entry appears adequate to prevent underseepage infiltration. Some improvements to the pumping station are planned for this site. However, due to the limited aquifer thickness, it will not be necessary to install fully-penetrating relief wells to the bedrock surface for control of uplift pressures at the pumping station.

SLOPE PROTECTION

A heavy growth of timber exists along the proposed alignment. This timber presently provides limited protection to control erosive action along the existing embankment. Since this project will incorporate the construction of new impervious fill levee embankments by removal and replacement of the existing levee embankments, it is uncertain whether all, a portion of, or none of the timber growth will be removed during construction for this project. In general, past history concern of the Des Moines River indicates the effect of wave wash is considered minimal whereas over-bank velocity flooding is considered to be a major issue. Duration of over bank flooding along the Des Moines River has historically been shown to be 1.9 days per year. Recent on site inspection has given evidence to velocity erosion in isolated reaches. For this project, these new embankments will be heavily seeded with appropriate grasses to provide effective vegetative slope protection. Only time and performance of the new embankments will determine whether the addition of riprap and bedding stone should be provided to prevent erosive and undermining action by flow velocities.

AVAILABILITY OF CONSTRUCTION MATERIALS

For this project, it is proposed to remove the existing levee embankments by bulldozers and scrapers. The purpose for this is to re-use these impervious fill soils (reference Boring Logs I, Boring Logs II, Geologic Profile I, and Geologic Profile II, plates J-3 and J-4) to construct the new earthen levee embankments. This material will provide the majority of the needed borrow materials for the project.

As discussed previously in this appendix, the existing levee embankments are generally composed of CL soils classified as sandy lean clay. This classification is in conformance with the Unified Soil Classification System. However, it must be emphasized herein that the embankment fill additionally contains various unknown quantities of both suitable and unsuitable components. The "suitable components" encountered are in the form of gravel and pockets of sand. The "unsuitable components" encountered are in the form of concrete rubble, fragments of brick and bedrock shale. During construction, the contractor shall be directed to remove these unsuitable components (as much as feasible), and to mix and blend these soils thoroughly prior to placement and compaction.

A standard Proctor moisture-density compaction curve (plate J-9) was run on a mixture of these existing levee embankment fill soils. The soils used for this test were collected from a series of left-over bag samples obtained from bore holes D-1 through D-7, following designated laboratory testing. The purpose of this exercise was to determine conditioning limitations for a mixture of these fill soils and to provide moisture-density construction guidelines. Proctor results of the fill soils mixture indicated the soils to be classified as sandy lean clay with Atterberg limits of 38/18 (liquid limit over plastic limit), percent passing the number 200 mesh sieve at 65 percent, and a specific gravity at 2.72. Optimums for this soil indicated a maximum dry density of 110.2 pounds per cubic foot at an optimum moisture content of 16.8 percent. Evaluation of all embankment bore holes indicated the in-situ moisture contents to range from 11 to 29 percent. An average of 18.6 percent moisture content represented the samples tested. An average of 17.7 percent moisture content with an average Atterberg limit of 36/20 represented all existing embankment soils. At this average in-situ moisture content, the soil is in an "acceptable state". Evaluation of these facts indicates the levee embankment fill soil is suitable and acceptable for use in construction of the compacted levee embankment sections. It appears these soils will require limited conditioning prior to placement and compaction.

Also for this construction project, an effort was made to locate additional suitable impervious borrow on site. The search centered around the proposed adjacent ponding area located some 300 feet west of the Indiana Avenue pump station. At the direction of CEMVR-ED-G, this site was explored for suitable borrow with the addition of two bore holes. This drilling was a portion of the initial contract established with Terracon to drill pre-determined bore holes along the proposed levee alignment. Bore hole locations were laid out on site by ED-G and ED-DM personnel. Location and the logs of the two bore holes are as shown (reference D-8 and D-9, Boring Logs II, plate J-4). The purpose of the

additional borrow explorations was to determine the type and extent of impervious top-stratum soils available. Representative samples were obtained by methods previously addressed. The boreholes were advanced some 13 feet to termination depth. Both split-barrel (split-spoon) and thin-walled tube methods were used to extract soil samples. Bulk samples were obtained for Proctor testing.

Stratification boundaries of soil types were determined from the boring logs. The bore holes confirmed that the suitable impervious top-stratum CL soil did exist but lay beneath a layer of miscellaneous fill. The miscellaneous fill was found to extend some 3 to 5.5 feet below the ground surface. A portion of this fill was deemed suitable (CL soils) while the remainder was deemed unsuitable rubble fill. Beneath this fill lay the impervious top stratum soil that extended some 2 to 2.5 feet in depth. The bottom of the top stratum CL soils strata was found to be at or above ground water level. Beneath this lay the pervious aquifer SP-SM soils to termination depth of 13 feet.

A standard Proctor moisture-density compaction curve (plate J-10) was run to determine conditioning limitations of the soils obtained from the proposed ponding area. The soils used for this test was a composite sample of the impervious top stratum native CL sandy lean clay soils obtained from borings D-8 and D-9 as shown on Boring Logs II, plate J-4. The purpose of the Proctor test was to provide moisture-density construction guidelines. Proctor results of the composite sample indicated the soils to be classified as sandy lean clay with Atterberg limits of 38/20 (liquid limit over plastic limit), percent passing the number 200 mesh sieve at 70 percent, and a specific gravity at 2.67. Optimums for this soil indicated a maximum dry density of 109.2 pounds per cubic foot at an optimum moisture content of 16.3 percent. The bore holes indicated the in-situ moisture contents to range from 26 to 28 percent. At these in-situ moisture contents, the soil is in a "too-wet" state. Evaluation of these facts indicate the impervious borrow soil is suitable and acceptable for use in construction of the compacted levee embankment sections but will require sufficient drying back before placement and compaction can take place.

In summary, the contractor will be encouraged to thoroughly blend all borrow soils either prior to placement or during placement before compaction operations can be initiated. The purpose for this is in order to achieve proper conditioning and uniform maximum density. Soils borrowed from the existing levee embankment are anticipated to be at or near optimum moisture content and should require very little conditioning. Soils borrowed from the ponding area are anticipated to require conditioning; drying back. The amount of drying back will vary in relation to the mixing of

soils. A "shrinkage factor", not to exceed 25 percent, should be anticipated for these soils.

Pervious sand borrows necessary for depression filling and/or pervious free-draining underseepage berms can be obtained from local sources. Sand from these sources should be relatively well graded with less than 5 percent by weight passing the No. 200 sieve. The preferred sand should be comparable to a typical Mississippi River sand classified as SP coarse to fine. This sand shall comprise a D_{10} (effective grain size) size ranging from 0.12 to 0.55 millimeters and having a desired average of 0.25 millimeters. Available sand shall be examined and tested for conformance to the preferred sizing before placement.

Protection (riprap and bedding) and roadway stone are available in the immediate area, as are concrete coarse and fine aggregates. Should it be necessary to provide riprap for velocity protection, the stone shall be required to be taken from Corps ED-G approved quarry ledges. It is anticipated the sizing of the stone, if required, would be the typical Corps recommended 400 pound maximum size requiring a minimum of 18 inches placed atop 6-inches of bedding. To acquire quality stone, a substantial hauling distance will be necessary. Hauling approved stone to the project site by truck from Central Iowa will entail a one-way travel distance of 50 miles. Hauling approved stone to the project site by rail from South Dakota will entail a travel distance far in excess of 50 miles. Stone from either location is anticipated to be cost comparable, regardless of transportation distance.

MATERIAL UTILIZATION

It is anticipated that only limited amounts of unsuitable materials, in the form of rubble fill, will be encountered at the project site. This material will require excavation and removal. The rubble fill was confirmed by explorations performed by Terracon and CEMVR-ED-G within the project alignment corridor. It is presumptuous to confirm the extent of the rubble fill from only the exploratory findings. Isolated areas of rubble fill would have less than a significant impact on the project site as opposed to expanded areas. Only one rubble fill area of excessive size was uncovered within the existing levee embankments during the recent mechanical exploratory drilling program. This observation indicated uncontrolled placement had occurred. For the most part, CL sandy lean clay soils dominated the soil type contained within the existing levee embankment soils. With only one known exception, the remaining existing levee embankment CL soils were found to contain only traces of rubble fill. It appears feasible, and with certainty, that the sandy CL soils of the existing levee

embankments can be reclaimed and reused in the construction of the new earthen levee embankments under the direction of the construction inspector. CL, CL-CH, CH and SC soils, removed from inspection trench excavations, can and shall be reused for either inspection trench or new levee embankment construction. Proper conditioning (either wetting or drying back) of these soils undoubtedly shall be necessary to some degree prior to placement and compaction. In sites where large quantities of unsuitable miscellaneous materials are encountered, removal off-site shall be necessary.

FLOOD HISTORY

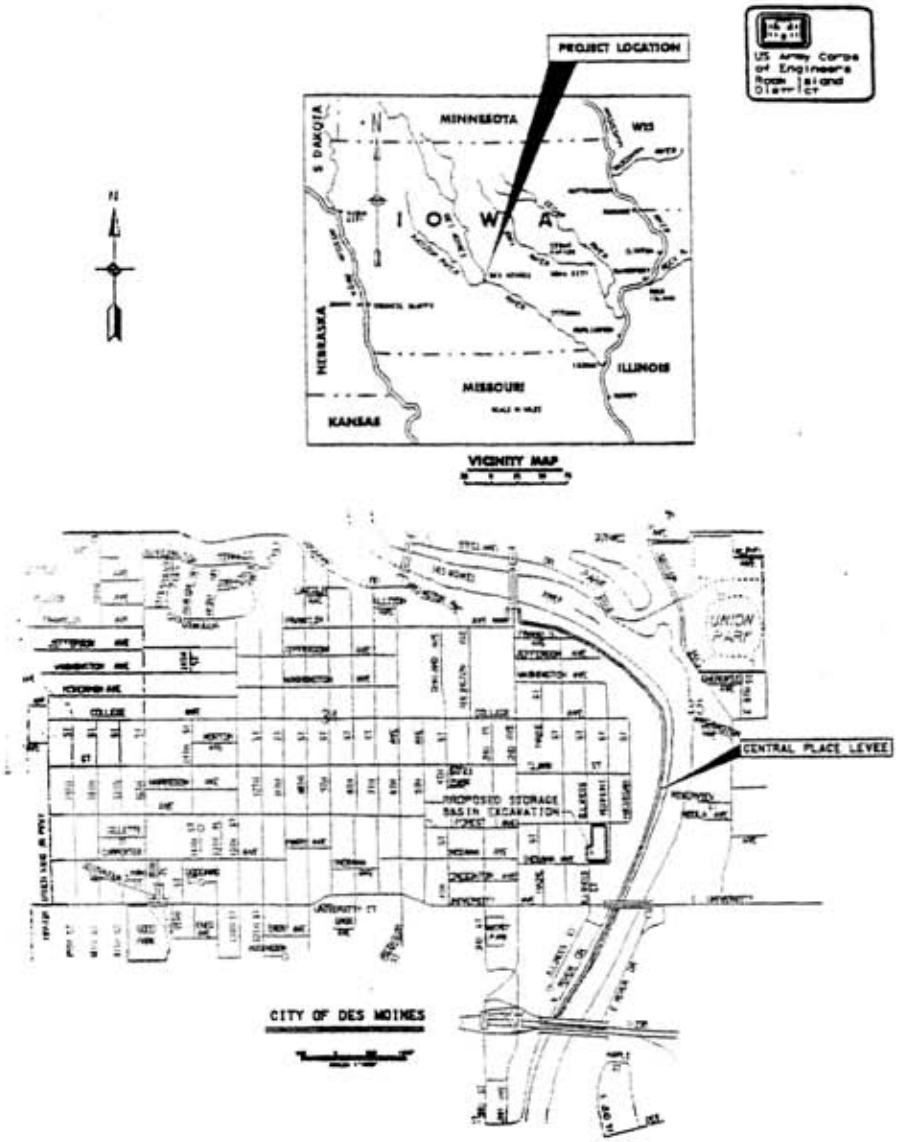
Historical records at 2nd Avenue in Des Moines, Iowa indicate that Des Moines River high water level elevations has been at and above flood stage (23 feet City Datum and 797 feet NGVD) some 55 days in the past 45 years (1955-1999). The most significant occurrences were recorded in years 1965, 1984, 1991, and 1993 where flood stage was exceeded some 11, 7, 2, and 28 days, respectively. Records were not available to determine continuous periods of time the Des Moines River was bank full. The peak water level for these floods was some 8 feet above the riverbank in 1993.

INSTRUMENTATION

Existing piezometers and/or ranges of piezometers are nonexistent at the project site. The need for installation of piezometers here would be to monitor groundwater fluctuations and underseepage pressures. This data would allow the engineer the opportunity to collect and evaluate high water data for use during construction for comparison with any required underseepage control measures. Throughout the project alignment, exploration data reveals variation in levee heights and subsurface stratum thick nesses. The levee height for this project varies from about 10 to 22 feet. The impervious top stratum thickness varies from 2 to 15 feet. The natural blanket length riverward to the underseepage entrance is estimated to vary in length from about 100 to 300 feet. The natural blanket length landward to the underseepage exit is infinite in distance. The pervious aquifer varies from 7 to 30 feet. Any consideration for placement of a piezometer range/s would most likely be at either the upstream or the downstream end of the project. These areas reveal the deepest pervious aquifer. However, the need to install a range of piezometers prior to or during construction is not apparent.

Existing settlement plates are nonexistent at the project site. The need for installation of settlement plates here, prior to construction, would serve to monitor settlement of the existing foundation soft clays and/or unsuitable

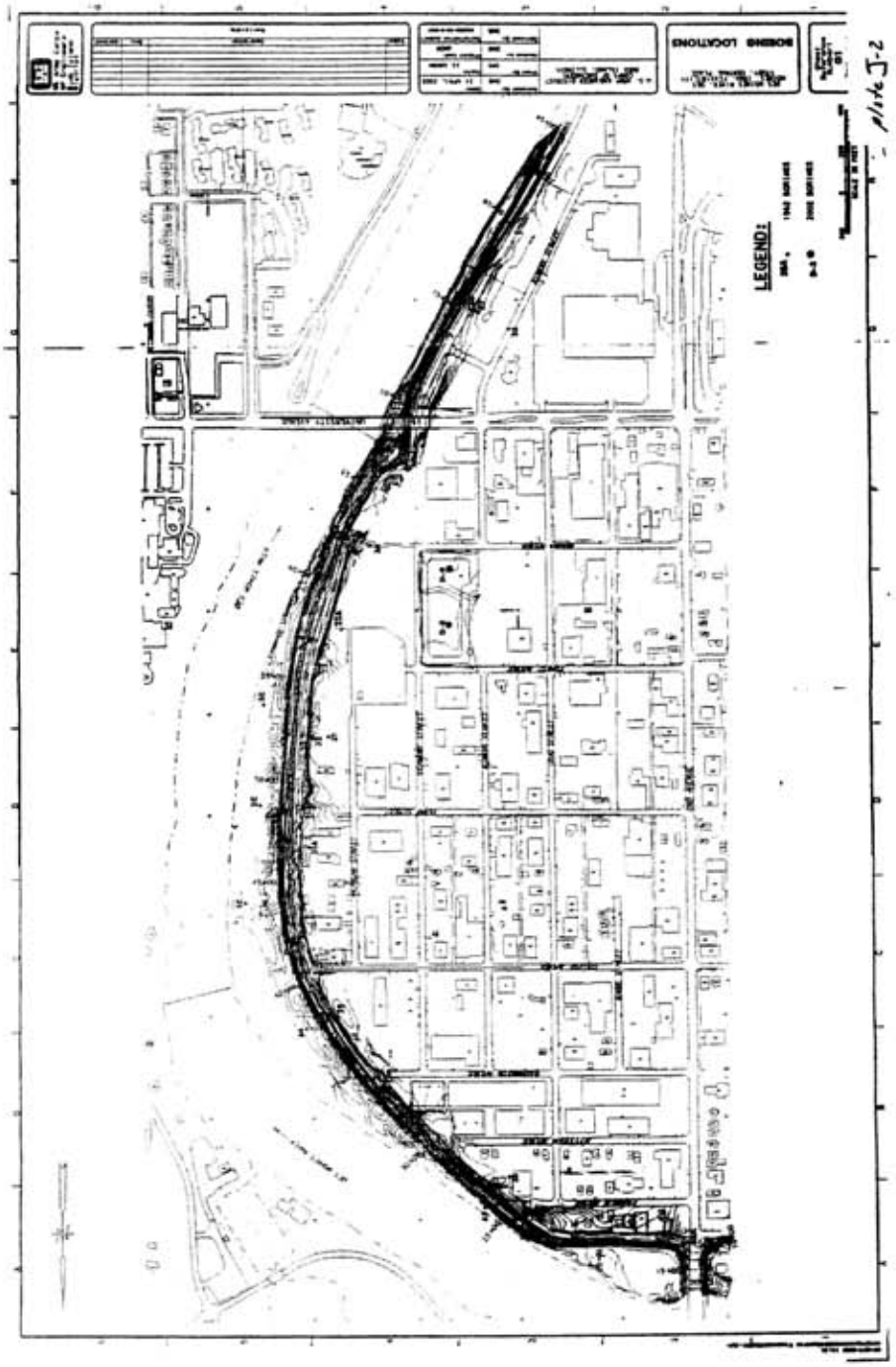
miscellaneous fill relative to the rate of embankment loading. From examination of all 1963 and 2002 exploratory bore holes, it is not apparent that the subsurface stratigraphy contains any questionable areas of soft soils or unsuitable miscellaneous fill within the entire project levee alignment conducive to require these installations. In addition and as stated before, it is highly likely that much of the subsurface compressible soils have been subjected to over consolidation from the weight of the existing levee embankment being in place since the early 1950's. At present, there are no plans to install settlement plates either in the foundation or the embankment during construction.

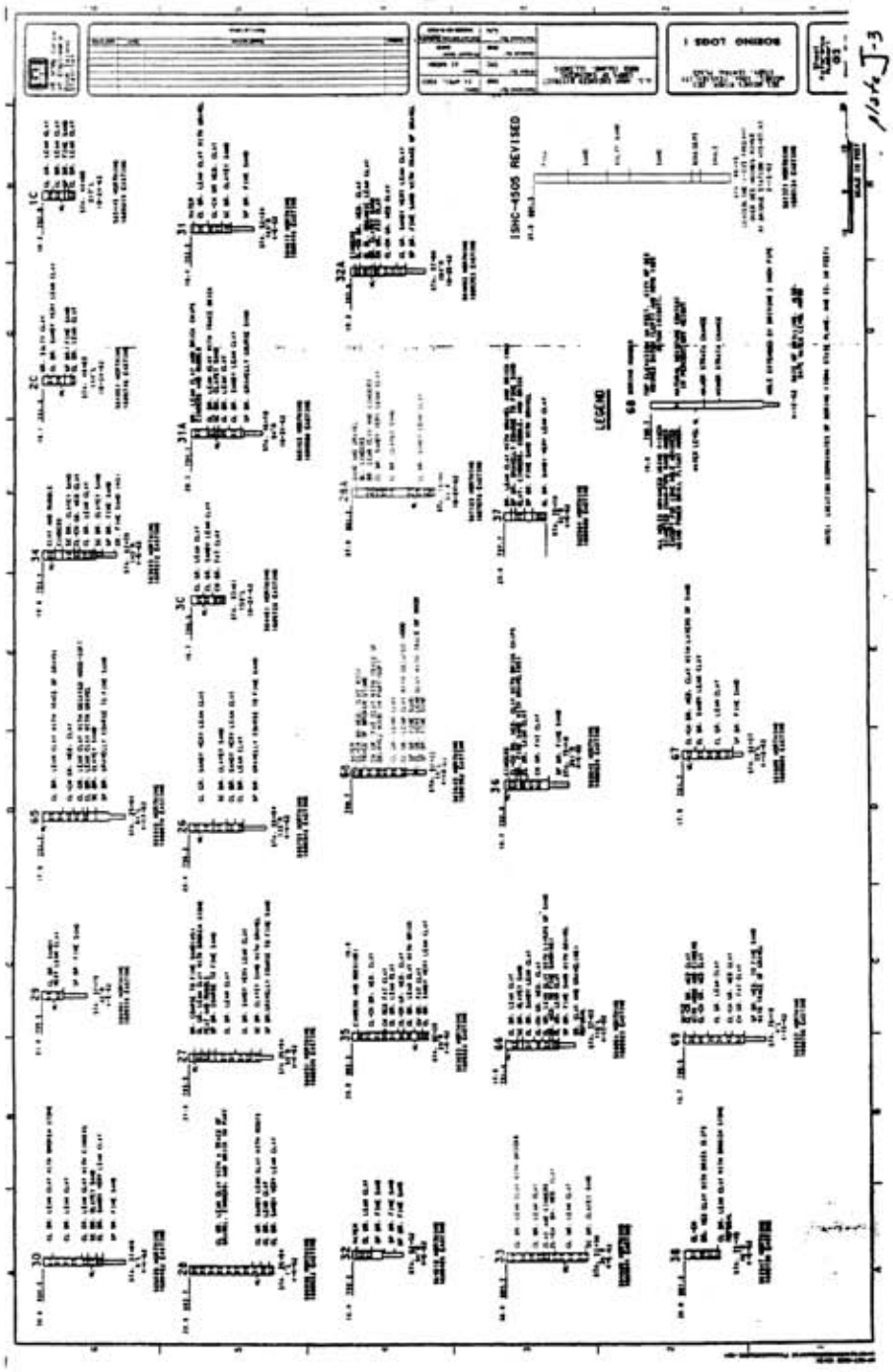


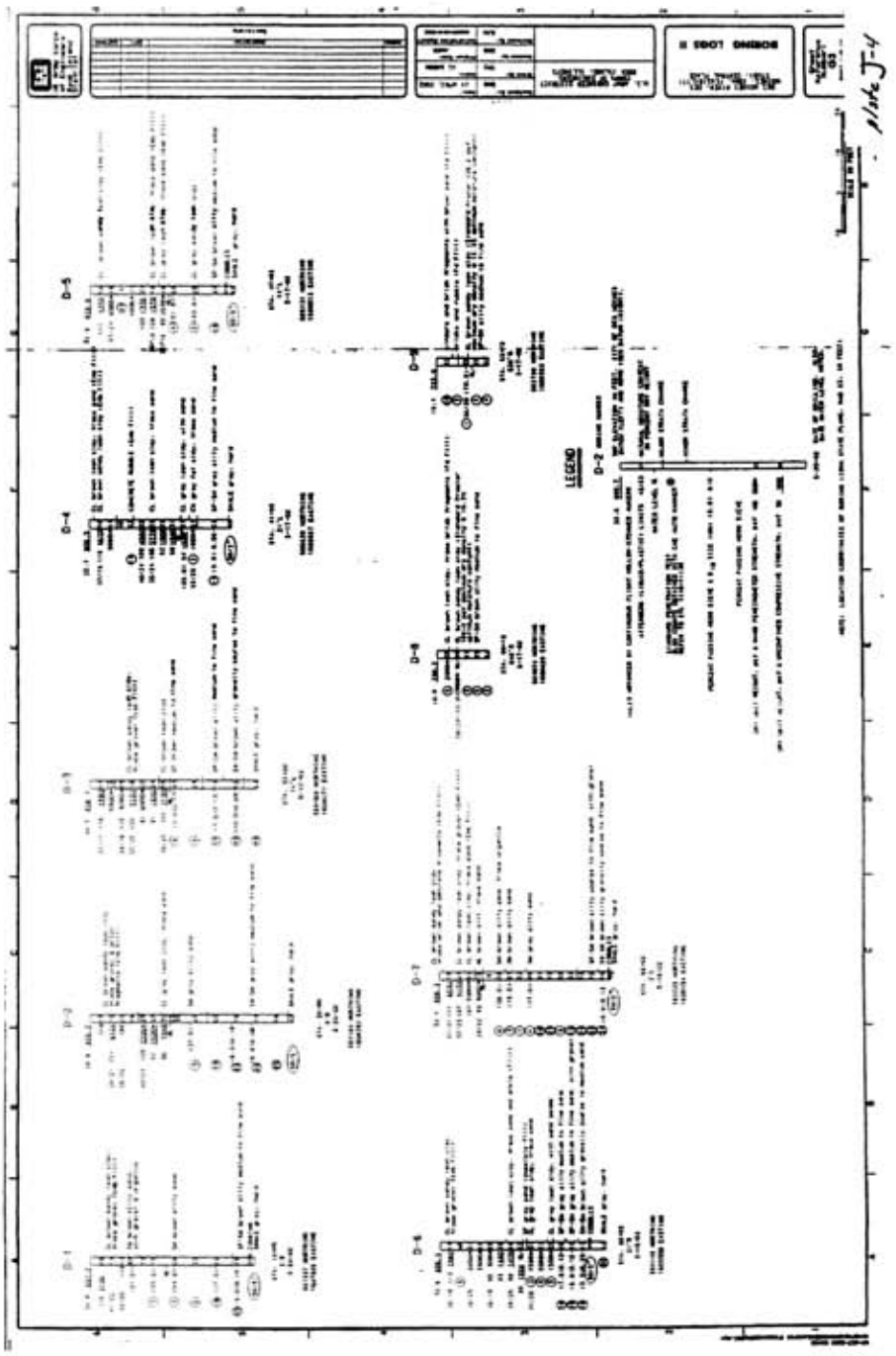
DES MOINES RIVER, DES MOINES, IOWA, FEASIBILITY STUDY, CENTRAL PLACE

CENTRAL PLACE SITE PLAN

Plate J-1


LEGEND:
BORING LOCATIONS





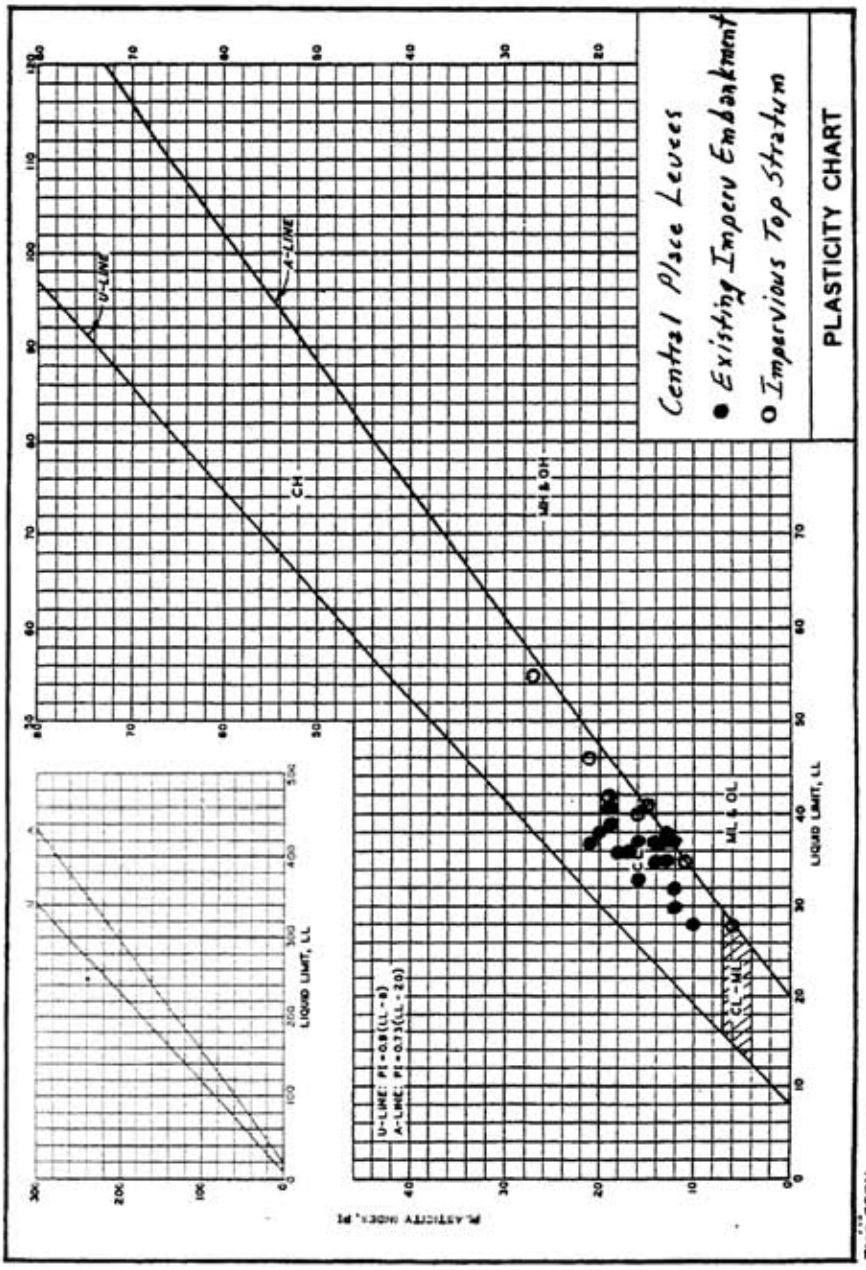
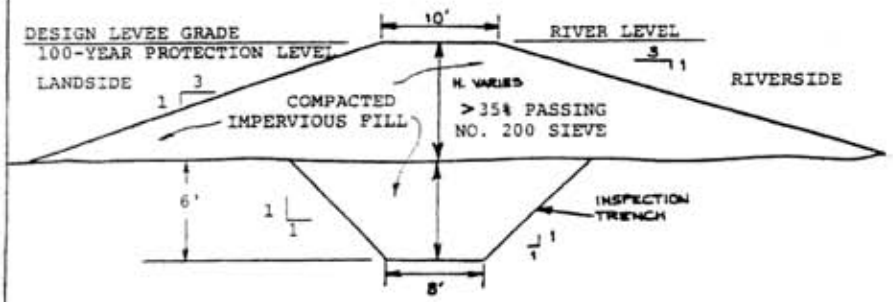
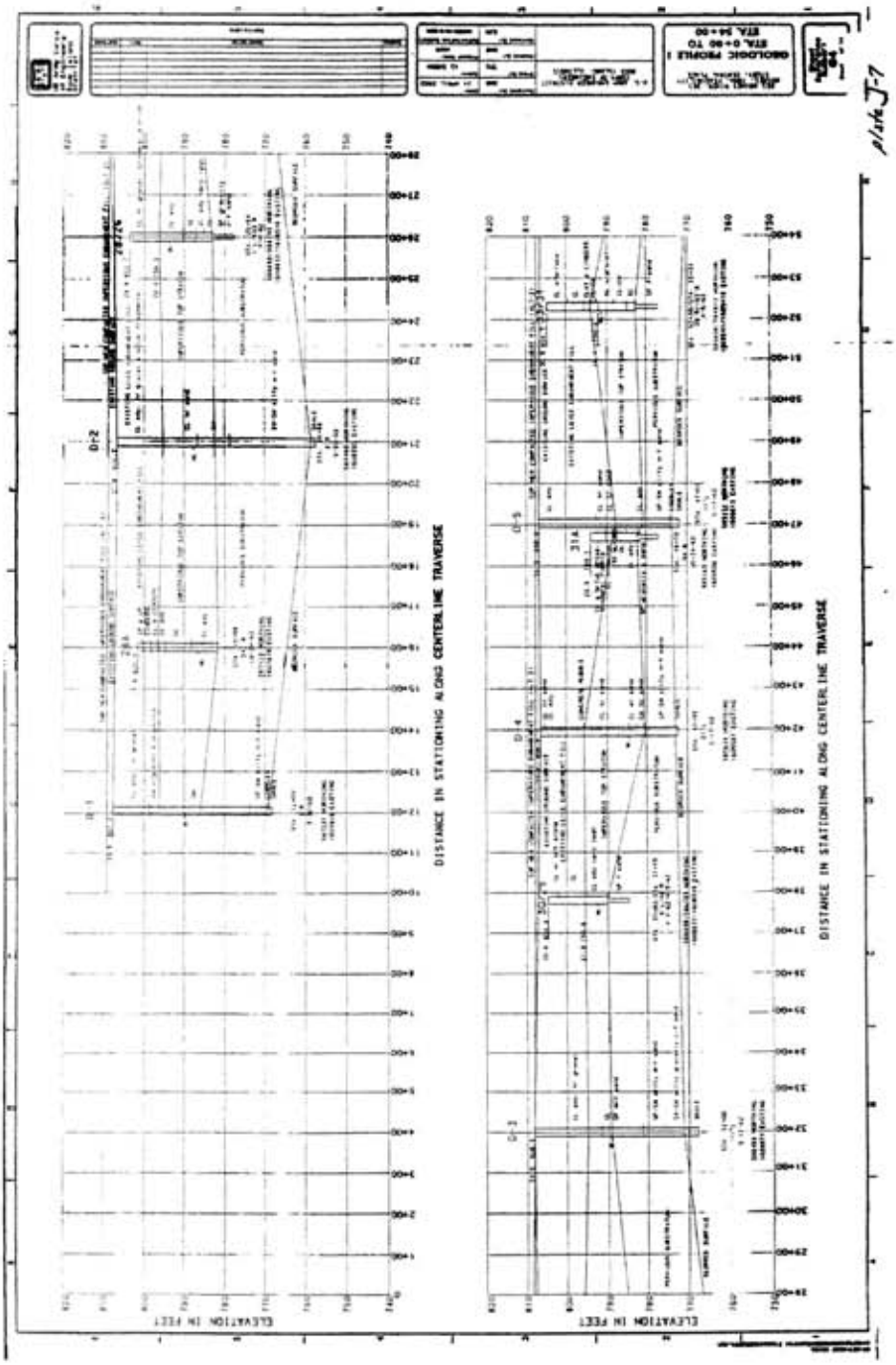

PLASTICITY CHART
Central Place Levees
● Existing Imperv Embankment
○ Impervious Top Stratum
U-LINE
A-LINE
CH
MH & OH
CL
ML & OL
CL-ML
LIQUID LIMIT, LL
PLASTICITY INDEX, PI
U-LINE: PI=0.9(LL-8)
A-LINE: PI=0.73(LL-20)
ENG FORM 4334 JUN 70
(EM 1110-2-1906)
TRANSLUCENT

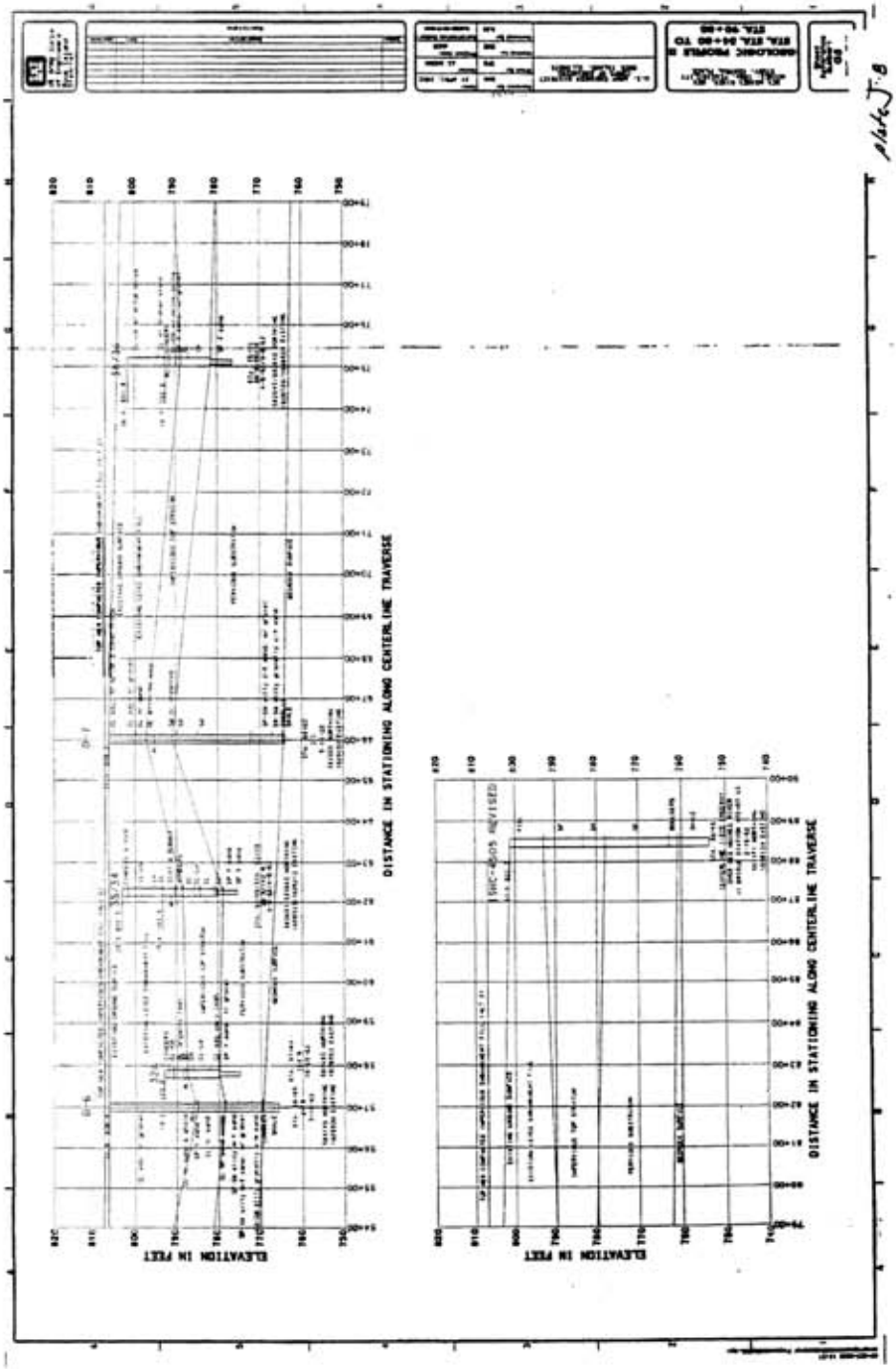
plate J-5



TYPICAL SECTION NEW LEVEE

DES MOINES RIVER
DES MOINES, IOWA
TYPICAL
LEVEE SECTION
plate J-6


GEOLOGIC PROFILE I
STA. 0+00 TO
STA. 54+00
DISTANCE IN STATIONING ALONG CENTERLINE TRAVERSE
ELEVATION IN FEET
DISTANCE IN STATIONING ALONG CENTERLINE TRAVERSE
ELEVATION IN FEET


DISTANCE IN STATIONING ALONG CENTERLINE TRAVERSE
ELEVATION IN FEET
DISTANCE IN STATIONING ALONG CENTERLINE TRAVERSE
ELEVATION IN FEET

Terracon

Laboratory Compaction Characteristics of Soil

600 SW 7th Street, Suite M
Des Moines, Iowa 50309
515-244-3184

Client Name: MISSMAN STANLEY
Project Name: CENTRAL PLACE LEVEE
Location: COMPOSITE SAMPLE FROM BORINGS 8 AND 9 OF THE NATIVE BROWN SANDY LEAN CLAY
Source Material: BORINGS 8 (3 to 5 ft.) and 9 (5.5 to 8 ft.)
Sample Description: DARK BROWN SANDY LEAN CLAY
SPECIFIC GRAVITY = 2.67
Material Designation: _____ Sample date: _____
Test Method: ASTM D-698
Test Procedure: Method A
Sample Preparation: WET
Rammer: X Mechanical ___ Manual

Project No.: 08025042 Date: 06/04/2002

TEST RESULTS
Maximum Dry Unit Wt.: 109.2 pcf
Optimum Water Content: 16.3 %

Liquid Limit: 38 Plastic Limit: 20
Plasticity Index: 18
% passing # 200 sieve: 70

Reviewed by: PJF

Zero air voids for specific gravity of 2.68

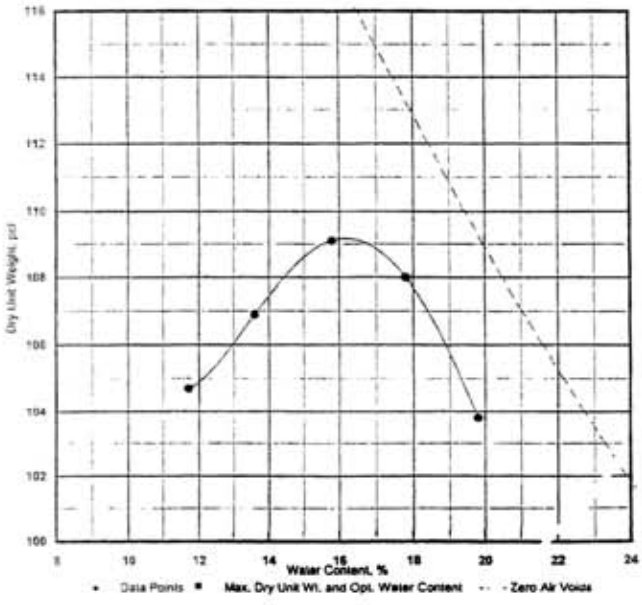


plate J-10

Terracon

Laboratory Compaction Characteristics of Soil

600 SW 7th Street, Suite M
Des Moines, Iowa 50309
515-244-3154

Client Name: MISSMAN STANLEY CONSULTANTS, INC
Project Name: CONTRAL PLACE LEVEES
Location: DES MOINES, IOWA

Source Material: EXISTING LEVEE FILL BORINGS 1 THRU 7
Sample Description: SANDY LEAN CLAY
Specific Gravity = 2.72
Material Designation: ____ Sample data: ____
Test Method: ASTM D-698
Test Procedure: Method A
Sample Preparation: WET
Rammer: X Mechanical ___ Manual

Project No.: 08025042 Date: 10/8/2002

TEST RESULTS
Maximum Dry Unit Wt.: 110.2 pcf
Optimum Water Content: 16.8 %

Liquid Limit: 38 Plastic Limit: 18
Plasticity Index: 20
% passing # 200 sieve: 65

Reviewed by: CAS

Zero air voids for specific gravity of 2.72

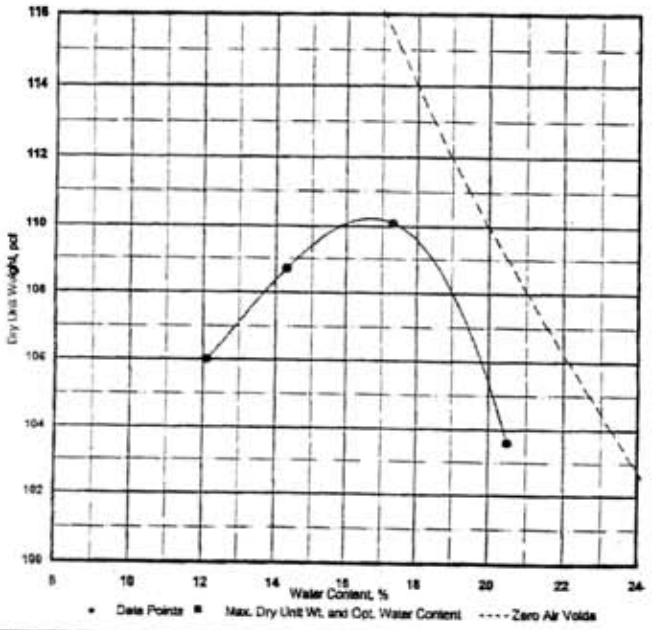


plate J-9

Standard Proctor Moisture-Density Test Evaluation

Test Method ASTM-D-698, Method A, Wet Sample Preparation, Mechanical Rammer

Curve Number	**2**
Desired Percent Optimum Moisture Control Limits	**90 to 110**
Allowable Range of Moisture Contents, percent	**15.1 to 18.5**
Optimum Moisture Content, percent	**16.8**
Allowable Deviation from Optimum Moisture Content, percent	**-1.7 to +1.7**
Selected Deviation from Optimum Moisture Content, percent	**-2.0 to +2.0**
Range of Natural Moisture Contents, percent	**11 to 29**
Average of Natural Moisture Contents, percent	**17.7**
Deviation of Average Natural Moisture Content from Optimum Moisture Content, percent	**+0.9**
Maximum Dry Density, pounds per cubic foot	**110.2**

Composite Sack Sample from Borings 8 & 9

Classification USCS Symbol	CL brown sandy lean clay - existing levee fill
Atterberg Limits	38/18
Specific Gravity	2.72
Borrow Source	on-site

Central Place Levee
Proposed Borrow Sources
Moisture Control Evaluation

plate J-11

Standard Proctor Moisture-Density Test Evaluation

Test Method ASTM-D-698, Method A, Wet Sample Preparation, Mechanical Rammer

Curve Number	1
Desired Percent Optimum Moisture Control Limits	90 to 110
Allowable Range of Moisture Contents, percent	14.7 to 17.9
Optimum Moisture Content, percent	16.3
Allowable Deviation from Optimum Moisture Content, percent	-1.6 to +1.6
Selected Deviation from Optimum Moisture Content, percent	-2.0 to +2.0
Range of Natural Moisture Contents, percent	26 to 28
Average of Natural Moisture Contents, percent	27
Deviation of Average Natural Moisture Content from Optimum Moisture Content, percent	+10.7
Maximum Dry Density, pounds per cubic foot	109.2

Composite Sack Sample from Borings 8 & 9

Classification USCS Symbol	CL native brown sandy lean clay
Atterberg Limits	38/20
Specific Gravity	2.67
Borrow Source	on-site

Central Place Levee
Proposed Borrow Sources
Moisture Control Evaluation

plate J-12

CENTRAL PLACE LEVEE
DES MOINES RIVER, IOWA
SUMMARY OF EXISTING SOILS THICKNESSES

BORING NUMBER	STATION	EXISTING EMBANKMENT	IMPERVIOUS TOP STRATUM	PERVIOUS SUBSTRATUM	BEDROCK SURFACE
		Thickness in feet	Thickness in feet	Thickness in feet	Elevation
D-1	12+05	9.0	0.0	28.5	769.0
28A	15+98	10.0	15.0	17.0*	765.0*
D-2	20+98	11.5	8.5	28.0	758.5
28/26	25+94	11.0	13.0	19.0*	765.0*
D-3	32+00	16.5	2.5	18.0	771.5
30/29	37+80	11.5	5.5	18.0*	772.0*
D-4	41+95	10.5	15.5	7.5	773.0
31A	46+70	18.0	6.0	8.5	774.0*
D-5	47+03	19.0	7.0	7.0	774.0
33/31	52+32	12.0	11.5	11.0	771.5*
D-6	56+99	21.5	6.5	9.0	769.5
32A	57+80	19.0	7.5	10.5	769.0*
35/34	62+32	18.0	9.5	12.0	766.5*
D-7	66+02	9.0	2.0	31.0	764.5

NOTES:
Existing Embankment Fill Soils: CL sdy, CL, CL-CH, CH, rubble
Impervious Top Stratum Soils: CL, CL sdy, CL-CH, CH, SC, ML
Pervious Substratum Soils: SM, SW-SM, SP, SP-SM, cobbles
Bedrock Shale, Pennsylvanian System, Des Moines Series
* Estimated

plate J-13

Central Place Levees - Des Moines and Raccoon Rivers Feasibility Study
Summary of Cohesive Shear Strength Tests
Unconfined Compression vs Estimated Unconsolidated Undrained by Moisture Content Correlation

Boring Number	Depth feet	LL/PL	Wo %	Dry Unit Weight pcf	Cohesion UC Test psf	Cohesion UU Test psf	Classifictn	Location
D-1	2.5		16	115	1565		CL sdy	embnkmt
	5.0	41/22	14				CL sdy	embnkmt
	7.5	32/20	11	119			CL sdy	embnkmt
D-2	2.5		17	118			CL sdy	embnkmt
	5.0	35/21	15	121	3060		CL sdy	embnkmt
	7.5	35/22	20	100			CL sdy	embnkmt
	10.0		19				CL sdy	embnkmt
	12.5	42/23	25	105	1750*	500	CL	top stratm
	15.0		25	92	1750*	500	CL	top stratm
	17.5		30	90	520	420	CL	top stratm
	20.0		19			660	CL	top stratm
D-3	2.5	33/17	17	116	2990		CL sdy	embnkmt
	5.0		12.5		2500*		CL sdy	embnkmt
	7.5	38/18	15	115	4500*		CL sdy	embnkmt
	10.0	37/25	18	100	2610		CL sdy	embnkmt
	12.5		20	91	3000*		CL sdy	embnkmt
	15.0		24	91	950		CL sdy	embnkmt
	17.5	46/25	15	101	1565	850	CL	top stratm
D-4	2.5	37/16	16	116	2335		CL sdy	embnkmt
	5.0		14		4500*		CL sdy	embnkmt
	7.5		NR				Conc Rbl	embnkmt
	10.0		12				Conc Rbl	embnkmt
	12.5	40/24	22	109	2290	560	CL	top stratm
	15.0	35/24	22	105	1885	560	CL	top stratm
	17.5		29	92	500	430	CL	top stratm
	20.0		31	90	520	400	CL	top stratm
	22.5		27	94	825	470	CL	top stratm
	25.0	55/28	57		500*	400+/-	CH	top stratm
D-5	2.5		16	117	2625		CL sdy	embnkmt
	5.0	37/24	16		4000*		CL sdy	embnkmt
	7.5		4	N=11	(1800)		CL sdy	embnkmt
	10.0		11		2000*		CL sdy	embnkmt
	12.5		21	105	665		CL sdy	embnkmt
	15.0	30/18	18	108	785		CL	embnkmt
	17.5	28/18	18	99	1750*		CL	embnkmt
	20.0		26	N=4	(500)	480	CL/SCsdy	top stratm
	25.0		28	N=2	(250)	450	CL/SCsdy	top stratm

Note: 4000* = Pocket penetrometer test (1800) = estimated 1/2 Qu strength N=11 = std N value

plate J-14

Central Place Levees - Des Moines and Raccoon Rivers Feasibility Study
Summary of Cohesive Shear Strength Tests
Unconfined Compression vs Estimated Unconsolidated Undrained by Moisture Content Correlation

Boring Number	Depth feet	LL/PL	Wo %	Dry Unit Weight pcf	Cohesion UC Test psf	Cohesion UU Test psf	Classifctn	Location
D-6	2.5	36/19	17	113	1980		CL sdy	embnkmt
	5.0		NR	N=5	(750)		CL sdy	embnkmt
	7.5	38/25	21		1000*		CL sdy	embnkmt
	10.0		23		1250*		CL sdy	embnkmt
	12.5	36/18	25	95	250*		CL sdy	embnkmt
	15.0		29	93	740		CL sdy	embnkmt
	17.5	39/20	28	98	735		CL	embnkmt
	20.0		27	98	975		CL	embnkmt
	22.5	41/26	31		750*	400	CL	top stratm
	22.5		31	N=3	(500)		CL	top stratm
	25.0		23		1000*	540	CL	top stratm
	25.0		23	N=6	(1000)		CL	top stratm
	27.5		29		750*	430	CL	top stratm
	27.5		29	N=5	(750)		CL	top stratm
D-7	2.5	37/21	15	117	3265		CL sdy	embnkmt
	5.0		21		2085		CL sdy	embnkmt
	7.5	37/23	20	107	2500*		CL	embnkmt
	10.0	28/22	19	92	2500*	>1000	ML	top stratm

Note: 4000* = Pocket penetrometer test (1800) = estimated 1/2 Qu strength N=11 = std N value

plate J-15

Central Place Levees - Des Moines and Raccoon Rivers Feasibility Study
Summary of Cohesive Shear Strength Tests
Unconfined Compression vs Estimated Unconsolidated Undrained by Moisture Content Correlation

Boring Number	Depth feet	LL/PL	Wo %	Dry Unit Weight pcf	Cohesion UC Test psf	Cohesion UU Test psf	Classifictn	Location
28A	4.0		21				CL	embnkmt
	6.0		18			700	CL sdy	top stratm
	8.0		15			720	SC	top stratm
	10.0		15			720	SC	top stratm
	12.0		-			-	SC	top stratm
	14.0		23			540	CL sdy	top stratm
	16.0		25			500	CL sdy	top stratm
	18.0		23			540	CL sdy	top stratm
	20.0		26			480	CL sdy	top stratm
28/26	2.0		22				CL	embnkmt
	4.0		22				CL	embnkmt
	6.0		24				CL	embnkmt
	8.0		23				CL	embnkmt
	10.0		23			540	CL sdy	top stratm
	12.0		19			660	CL sdy	top stratm
	14.16		17			640	SC	top stratm
	18.0		24			520	CL sdy	top stratm
	20.0		26			480	CL	top stratm
30/29	2.0		11				CL	embnkmt
	4.0		21				CL	embnkmt
	6.0		21				CL	embnkmt
	8.0		29				CL	embnkmt
	10.0		19			660	CL sdy	top stratm
	12.0		20			620	CL sdy	top stratm
31A	2.0		23				CL	embnkmt
	4.0		21				CL	embnkmt
	6.0		19			540	SC	top stratm
	8.0		28			450	CL	top stratm
	10.0		23			540	CL sdy	top stratm
33/31	2.0		19				CL	embnkmt
	4.0		20				CL	embnkmt
	6.0		26				CL	embnkmt
	8.0		22				CL	embnkmt
	10.0		21				CL	embnkmt
	12.0		27			>1000	CL-CH	top stratm
	14.0		26			480	CL	top stratm
	16.0		36			410	CL-CH	top stratm
	18.0		27			>1000	CL-CH	top stratm
	20.0		16			660	SC	top stratm

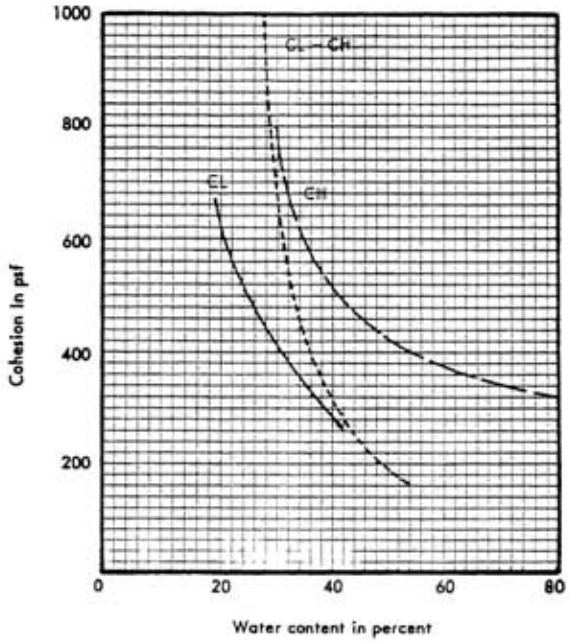
plate J-16

Central Place Levees - Des Moines and Raccoon Rivers Feasibility Study
Summary of Cohesive Shear Strength Tests
Unconfined Compression vs Estimated Unconsolidated Undrained by Moisture Content Correlation

Boring Number	Depth feet	LL/PL	Wo %	Dry Unit Weight pcf	Cohesion UC Test psf	Cohesion UU Test psf	Classifictn	Location
32A	2.0		21				CL-CH	embnkmt
	4.0		45				OL	embnkmt
	6.0		29			>1000	CH	top stratm
	8.0		24			>1000	CL-CH	top stratm
	10.0		23			>1000	CL-CH	top stratm
	12.0		23			540	CL sdy	top stratm
35/34	2.0		20				CL-CH	embnkmt
	4.0		23				CL-CH	embnkmt
	6.0		21				CL-CH	embnkmt
	8.0		25				CH	embnkmt
	10.0		24				CL	embnkmt
	12.0		22				CL	embnkmt
	14.0		-				Cinders	embnkmt
	16.0		18			420	SC	top stratm
	18.0		33			500	CL-CH	top stratm
	20.0		26			480	CL	top stratm
	22.0		28			450	CL	top stratm
	24.0		21			480	SC	top stratm

plate J-17

375-006

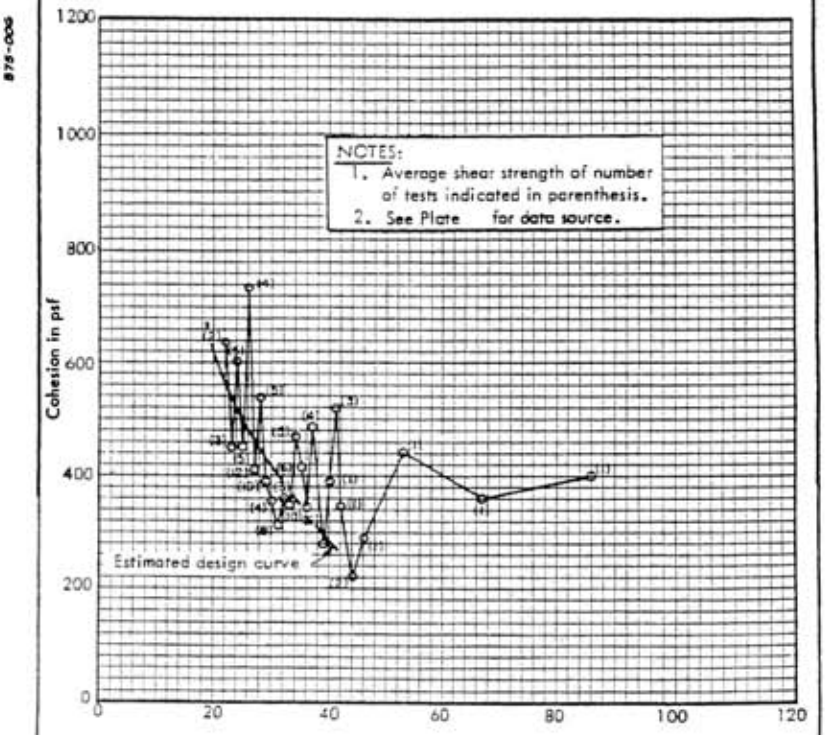


NOTE:

1. Cohesive shear strength curves derived from shear strength data supplied by Rock Island District for Mississippi River alluvial soils in the District, and shown on Plates , ,and .

COHESIVE SHEAR STRENGTH VS
WATER CONTENT

plate J-18



COHESIVE SHEAR STRENGTH
FOR CL SOILS VS
WATER CONTENT

plate J-19

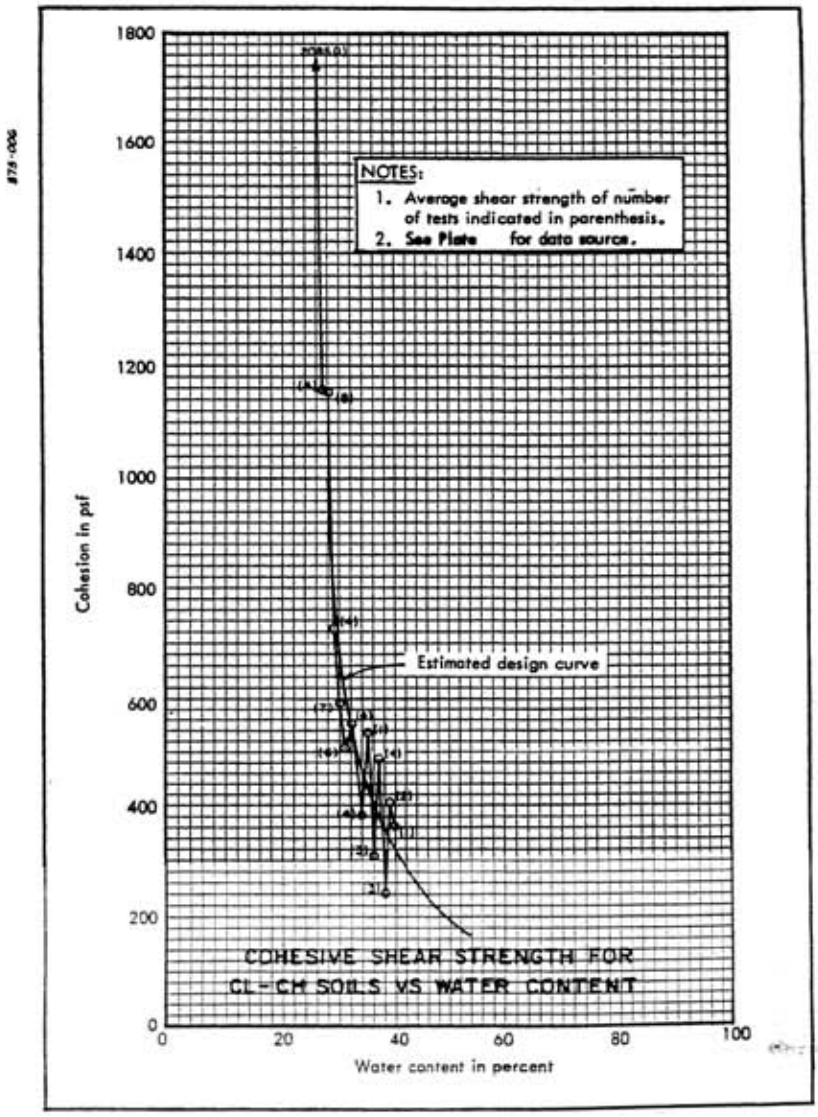
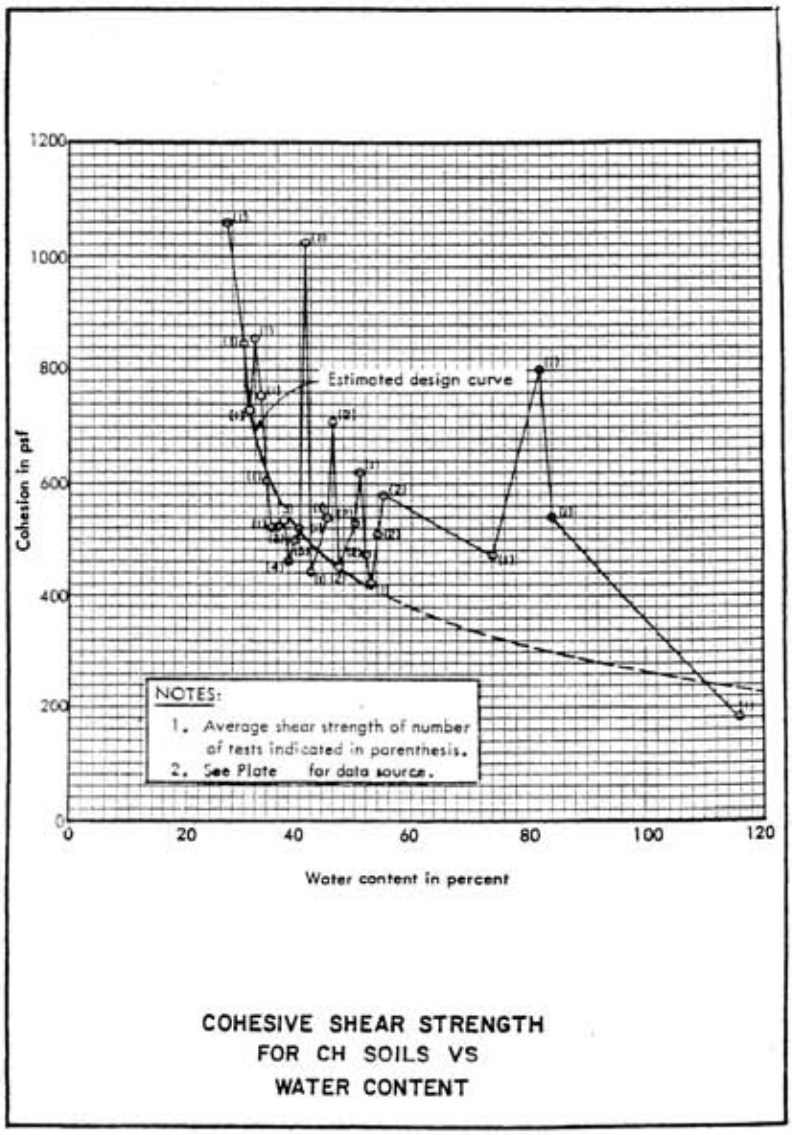
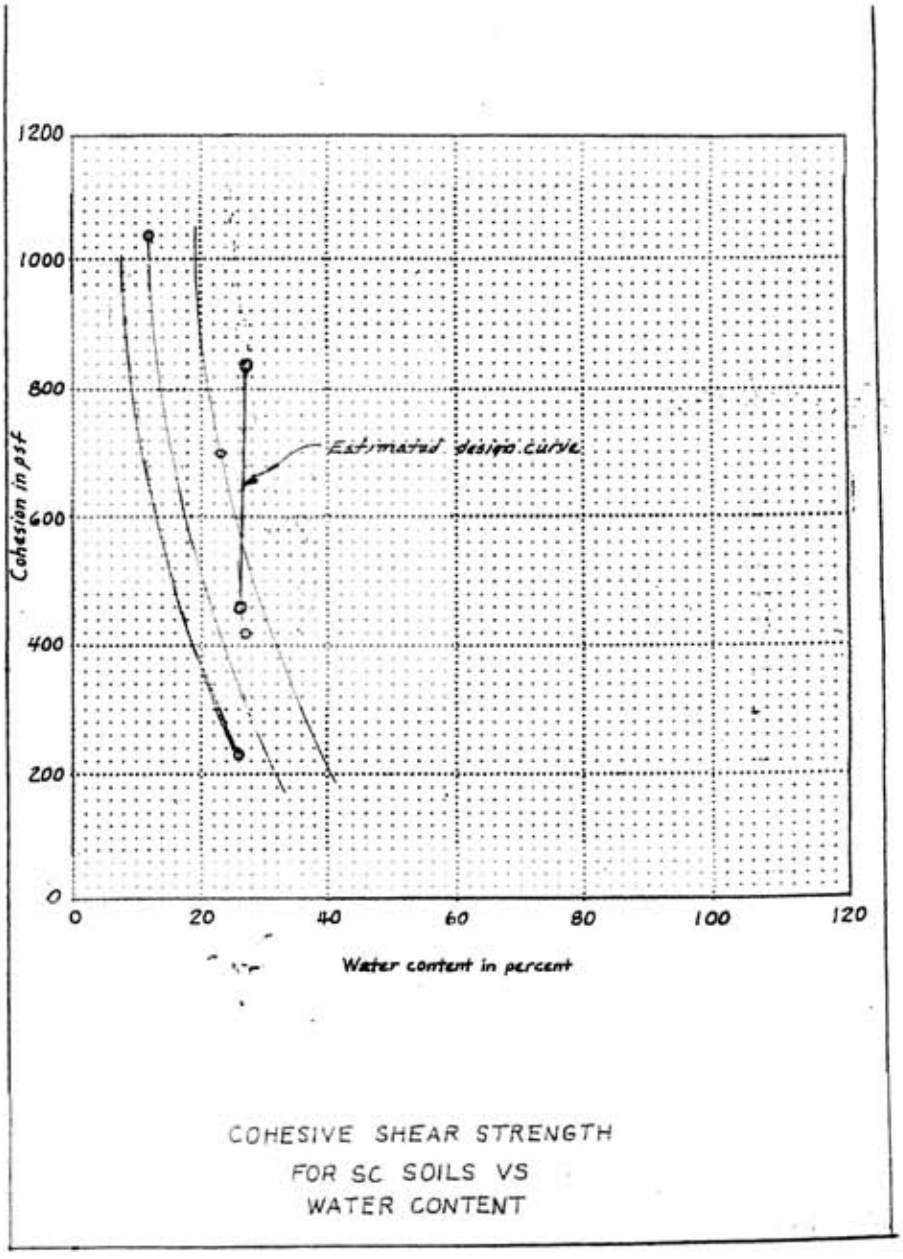

NOTES:
1. Average shear strength of number of tests indicated in parenthesis.
2. See Plate for data source.
Estimated design curve
COHESIVE SHEAR STRENGTH FOR
CL-CH SOILS VS WATER CONTENT
Cohesion in psf
Water content in percent
1800
1600
1400
1200
1000
800
600
400
200
0
0
20
40
60
80
100

plate J-20



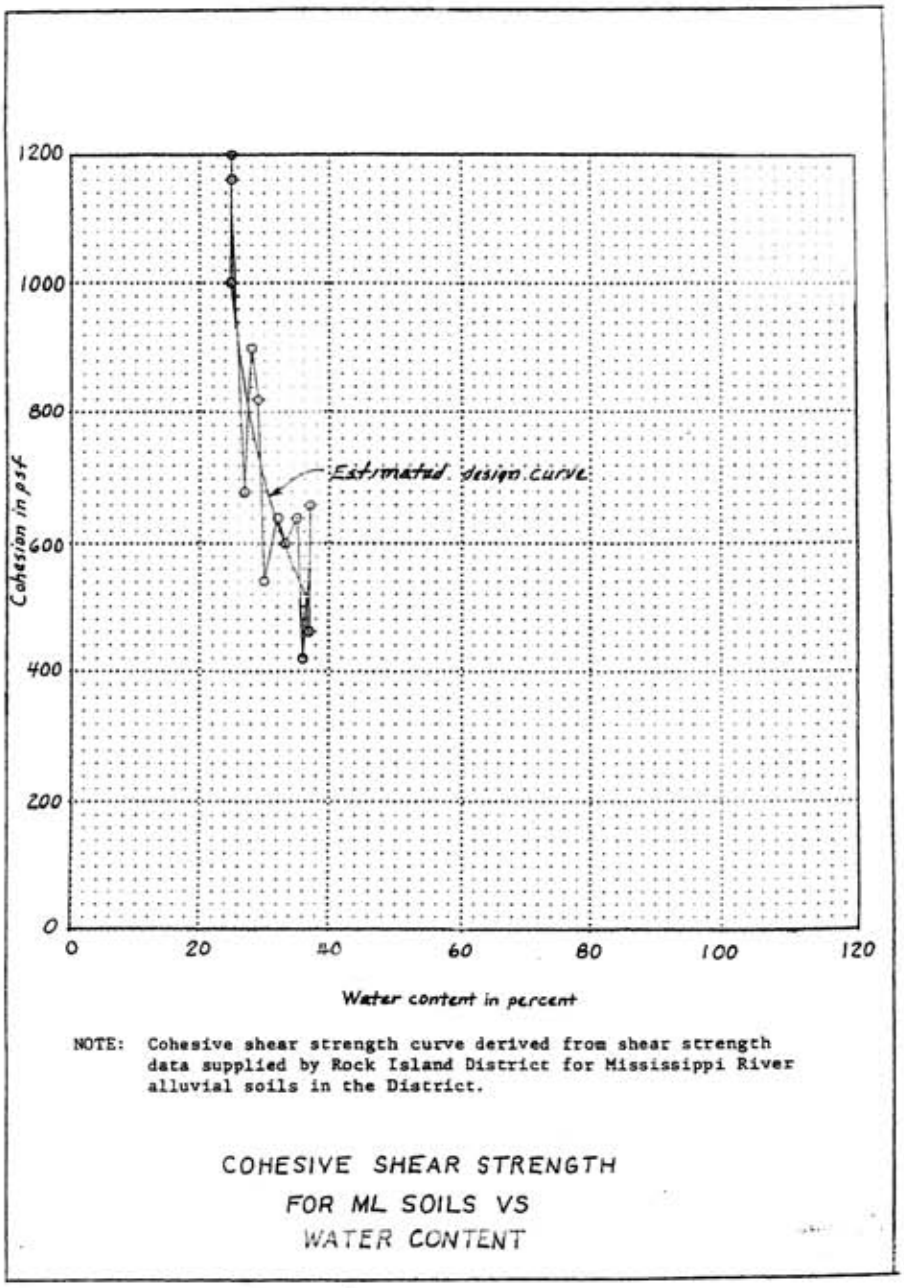
COHESIVE SHEAR STRENGTH
FOR CH SOILS VS
WATER CONTENT

Plate J-21



COHESIVE SHEAR STRENGTH
FOR SC SOILS VS
WATER CONTENT

plate J-22



NOTE: Cohesive shear strength curve derived from shear strength data supplied by Rock Island District for Mississippi River alluvial soils in the District.

COHESIVE SHEAR STRENGTH
FOR ML SOILS VS
WATER CONTENT

plate J-23

Central Place Levees - Des Moines and Raccoon Rivers Feasibility Study
Summary and Evaluation of Exploratory Findings and Soils Laboratory Testing
Ranges of Standard Penetration and Relative Density
Pervious Soils

2002 Mechanical Boring Number		USCS Symbol		Range of Standard Penetration blows per foot		# 200 Sieve Wash Percent Finer by Weight	Range of Relative Density
D-1		SM		2-18		21-44	loose to medium dense
		SP-SM		15		6	medium dense
D-2		SM		5		37	loose to medium dense
		SW-SM		10-30		6-9	dense
D-3		SP		6-8		3	loose
		SP-SM		19		7	medium dense
		SW-SM		40		10	dense
D-4		SP-SM		14		9	medium dense
D-5		SP-SM		18			medium dense
D-6		SP-SM		15-18		6-7	medium dense
		SW-SM		18		5	medium dense
D-7		SM		3-27		17-36	loose to medium dense
		SP-SM		14-22			medium dense
		SW-SM		31		8	dense

plate J-24

Central Place Levees - Des Moines and Raccoon Rivers Feasibility Study
Summary and Evaluation of Exploratory Findings and Soils Laboratory Testing
Ranges of Effective Grain Size and Coefficient of Permeability
Pervious Soils

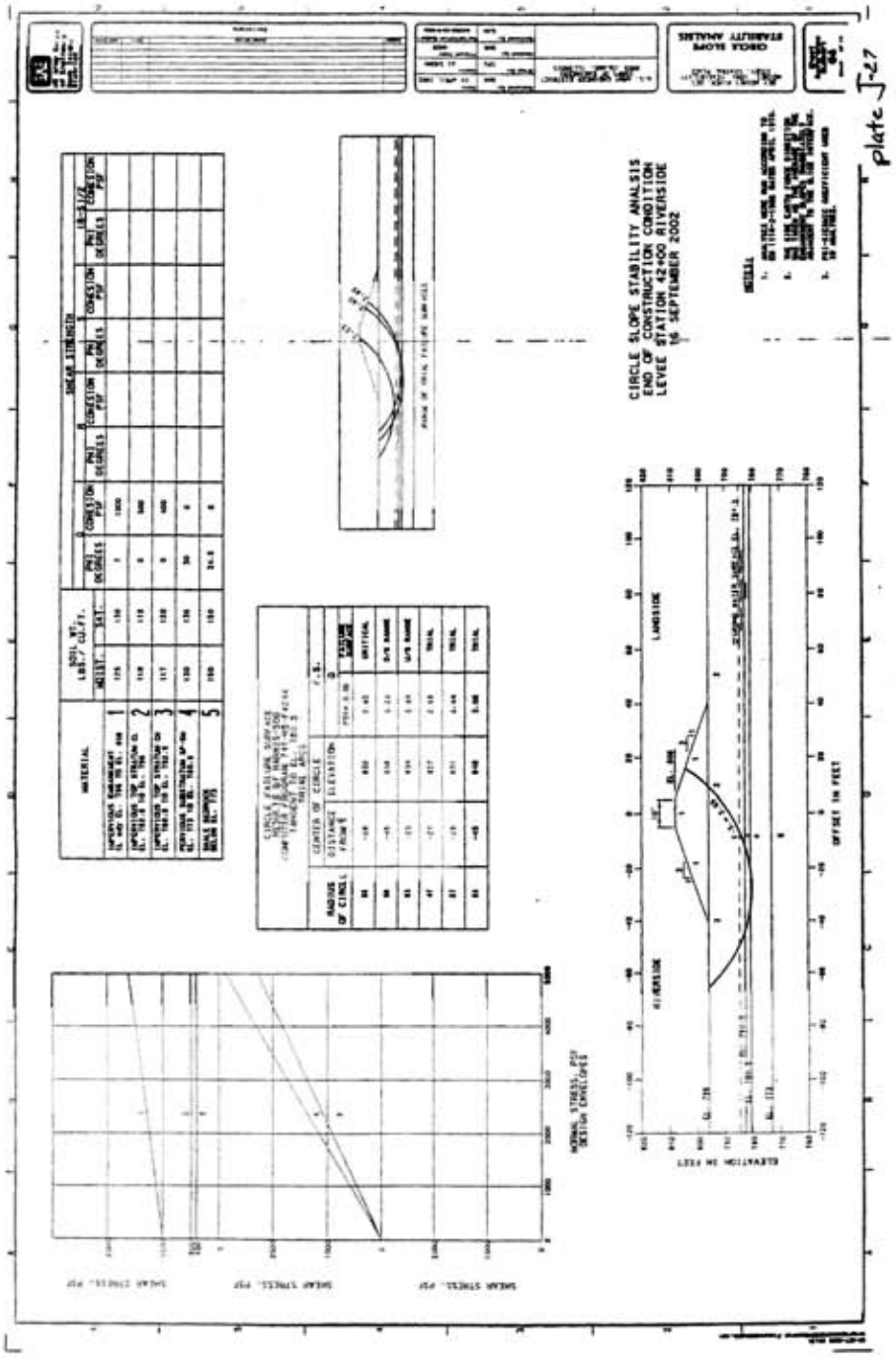
2002 Mechanical Boring Number	USCS Symbol	Range of Effective Grain Size (D10) millimeters	# 200 Sieve Wash Percent Finer by Weight	Range of Coefficient of Permeability (kh) centemeters per second
D-1	SM		21-44	
	SP-SM	0.14	6	0.05
D-2	SM		37	
	SW-SM	0.08-0.18	6-9	0.01-0.08
D-3	SP	0.17	3	0.07
	SP-SM	0.13	7	0.04
	SW-SM	0.09	10	0.02
D-4	SP-SM	0.08	9	0.01
D-5	SP-SM			
D-6	SP-SM	0.12-0.16	6-7	0.04-0.06
	SW-SM	0.29	5	0.18
D-7	SM		17-36	
	SP-SM			
	SW-SM	0.12	8	0.04

plate J-25

Central Place Levees - Des Moines and Raccoon Rivers Feasibility Study
Summary and Evaluation of Exploratory Findings and Soils Laboratory Testing
Des Moines Series Pennsylvanian System Formation
Bedrock

2002 Mechanical Boring Number		Rock Classification		Range of Standard Penetration blows per foot		Range of Consistency
D-1		Shale		50 / .42		moderately hard
D-2		Shale		50 / .25		moderately hard
D-3		Shale		44		moderately hard
D-4		Shale		50 / .25		moderately hard
D-5		Shale		50 / .42		moderately hard
D-6		Shale		50/1-50/.17		moderately hard
D-7		Shale		50 / .17		moderately hard

Plate J-26


CIRCLE SLOPE STABILITY ANALYSIS
END OF CONSTRUCTION CONDITION
LEVEE STATION 42+00 RIVERSIDE
16 SEPTEMBER 2002
plate J-27

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CENTRAL PLACE, DES MOINES RIVER,IOWA
CIRCLE SLOPE STABILITY ANALYSIS
END OF CONSTRUCTION CONDITION
LEVEE STATION 42+00 RIVERSIDE
16 SEPTEMBER 2002   DHB
0                              INPUT DATA

      MINIMUM ELEVATION OF CIRCLE= 780.5  X-START= -45.0  Y-START= 838.0
SEARCH INCREMENT= 10.0  F.S. MIN.= .000

      NUMBER OF LINES= 9  MINIMUM NO. OF SLICES= 20  SEISMIC COEFF.= .000
0  EMBANKMENT AND FOUNDATION PROFILE--

0       XTOEL      YTOEL      XTOPL      YTOPL      XTOER      YTOER
XTOPR      YTOPR
          .0         .0         .0         .0         .0         .0
.0          .0
0        X1(I)      Y1(I)      X2(I)      Y2(I)      TYPE

       -5000.0      796.0      -41.0      796.0         2
         -41.0      796.0       -5.0      808.0         1
          -5.0      808.0        5.0      808.0         1
           5.0      808.0       41.0      796.0         1
          41.0      796.0     5000.0      796.0         2
         -41.0      796.0       41.0      796.0         2
       -5000.0      782.5     5000.0      782.5         3
       -5000.0      780.5     5000.0      780.5         4
       -5000.0      773.0     5000.0      773.0         5
1
0  SOIL CONSTANTS--

      NUMBER OF SOIL TYPES= 5

0     TYPE NO.   WT.MOIST    WT.SAT.      C(1)      PHI(1)       C(2)
PHI(2)

          1         125.0      130.0     1000.0       7.0         .0
.0
          2         118.0      119.0      500.0        .0         .0
.0
          3         117.0      120.0      400.0        .0         .0
.0
          4         130.0      135.0         .0      30.0         .0
.0
          5         150.0      150.0         .0      24.5         .0
.0
0  PIEZOMETRIC SURFACE DATA--

0     NUMBER OF POINTS FOR PEIZOMETRIC SURFACE= 2

       XPIEZ(I)    YPIEZ(I)

       -5000.0       784.5
        5000.0       784.5
0  DRAWDOWN SURFACE DATA--

0     NUMBER OF POINTS FOR DRAWDOWN SURFACE= 0
```


plate J-28

1
CENTRAL PLACE, DES MOINES RIVER, IOWA
CIRCLE SLOPE STABILITY ANALYSIS
END OF CONSTRUCTION CONDITION
LEVEE STATION 42+00 RIVERSIDE
16 SEPTEMBER 2002 DHB

0	X-COORDINATE OF CENTER	Y-COORDINATE OF CENTER	FACTOR OF SAFETY
	-45.00	838.00	3.230
	-45.00	848.00	3.085
	-35.00	838.00	2.689
	-35.34	840.59	2.707
	-25.68	843.18	2.904
	-32.75	830.93	2.651
	-30.16	821.27	2.699
	-42.41	828.34	3.230
	-23.09	833.52	2.885
	-27.92	832.22	2.650
	-23.09	833.52	2.885
	-26.63	827.39	2.675
	-29.22	837.05	2.685

0 **********
0 MINIMUM FACTOR OF SAFETY = 2.650 LOCATED AT X= -27.92 Y= 832.22
0 NUMBER OF SLICES USED = 26 RADIUS OF CIRCLE = 51.72
0 **********

1
CENTRAL PLACE, DES MOINES RIVER, IOWA
CIRCLE SLOPE STABILITY ANALYSIS
END OF CONSTRUCTION CONDITION
LEVEE STATION 42+00 RIVERSIDE
16 SEPTEMBER 2002 DHB
0

CHECK DATA FOR CRITICAL ARC

FACTOR OF SAFETY= 2.650

LOCATION OF CENTER-- X= -27.92 Y= 832.22

RADIUS= 51.72

TABULATION OF SLICE DATA--

SLICE NO.	X-COORD. OF SLICE	SLICE WIDTH TOP	SLICE WIDTH BOTM.	TOTAL WT.	WATER FORCE E1	DIR. OF W.FORCE E2	C-FORCE DEVEL.	PHI DEVEL.	DIR. OF C-FORCE	NORMAL STRESS
1	14.03	3.35	1.27	.00	.00	2.16	2.65	54.19		.13
	.74	.0	.0	.00	.00					
2	10.67	3.35	3.48	.00	.00	1.90	2.65	48.26		.59
	2.95	.0	.0	.00	.85					
3	7.00	4.00	6.58	.00	.00	1.02	.00	42.47		1.47
	7.98	.0	.0	.85	5.48					
4	3.33	3.33	6.96	.00	.00	.79	.00	37.18		

plate J-29

```
1.95    8.14     .0    .0    5.48    9.77
  5       .00    3.33    7.88     .00     .00     .75     .00   32.67
2.24    8.88     .0    .0    9.77   13.93
  6     -3.33    3.33    8.65     .00     .00     .71     .00   28.39
1.70    6.43     .0   9.2   13.93   16.57
  7     -6.45    2.89    7.86     .00     .00     .60     .00   24.53
1.50    4.77    9.2  18.4   16.57   18.76
  8     -9.34    2.89    7.93     .10   90.00     .58     .00   21.06
2.39    7.41   18.4  18.4   18.76   20.99
  9    -12.23    2.89    7.93     .28   90.00     .57     .00   17.66
2.39    7.26   18.4  18.4   20.99   22.74
  10   -15.46    3.56    9.67     .55   90.00     .55     .00   13.94
2.38    8.72   18.4  18.4   22.74   24.39
  11   -19.02    3.56    9.46     .72   90.00     .55     .00    9.91
2.34    8.47   18.4  18.4   24.39   25.36
  12   -22.58    3.56    9.15     .83   90.00     .54     .00    5.93
2.29    8.21   18.4  18.4   25.36   25.68
  13   -26.14    3.56    8.72     .88   90.00     .54     .00    1.98
2.22    7.92   18.4  18.4   25.68   25.40
  14   -27.92     .00     .01     .00   90.00     .00     .00     .00
2.18     .01   18.4  18.4   25.40   25.40
  15   -27.92     .00     .01     .00   90.00     .00     .00     .00
2.18     .01   18.4  18.4   25.40   25.40
  16   -29.56    3.27    7.55     .81   90.00     .49     .00   -1.81
2.14    6.99   18.4  18.4   25.40   24.65
  17   -32.83    3.27    7.02     .77   90.00     .50     .00   -5.44
2.04    6.70   18.4  18.4   24.65   23.46
  18   -36.10    3.27    6.41     .68   90.00     .50     .00   -9.09
1.93    6.39   18.4  18.4   23.46   21.88
  19   -39.37    3.27    5.72     .55   90.00     .51     .00  -12.78
2.83    9.48   18.4   9.2   21.88   18.40
  20   -41.58    1.17    1.88     .16   90.00     .18     .00  -15.31
4.05    4.90    9.2    .0   18.40   16.69
  21   -44.06    3.78    5.77     .33   90.00     .75     .00  -18.18
1.50    5.96     .0    .0   16.69   14.12
  22   -47.84    3.78    5.13     .00   90.00     .77     .00  -22.64
1.44    5.88     .0    .0   14.12   11.14
  23   -51.62    3.78    4.35     .00     .00     .80     .00  -27.26
1.25    5.31     .0    .0   11.14    8.00
  24   -55.40    3.78    3.39     .00     .00     .84     .00  -32.08
1.02    4.53     .0    .0    8.00    4.88
  25   -59.17    3.78    2.23     .00     .00     .89     .00  -37.17
.73    3.47     .0    .0    4.88    2.07
  26    -62.95    3.78     .82     .00     .00     .97     .00  -42.63
.39    2.00     .0    .0    2.07     .00
0
     **NOTE-ALL ANGLES MEASURED FROM POSITIVE X-AXIS,FORCES ARE IN KIPS**

     **NOTE HORIZONTAL EARTHQUAKE FORCE MAY BE CALCULATED
     BY MULTIPLYING THE TOTAL SLICE WT. BY THE E.Q. COEFF.

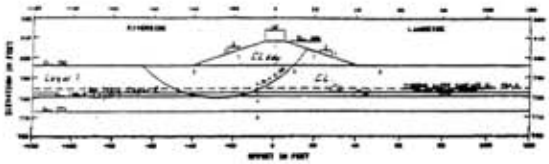
1
```


plate J-30

Des Moines and Raccoon Rivers Feasibility Study
Central Place Levees, Des Moines River, Des Moines, Iowa
Settlement Analysis

Assumptions:

Bore Hole D-4, Station 41+95
GWL at EL 784.5



Levee Embankment
CL sdy soils, gamma m=135

Compressible Impervious Top Stratum
Layer 1 CL soils, gamma m=118pcf, Wn=30%, WL=38%, Gs=2.67
Layer 2 CL soils, gamma s=119pcf, Wn=27%, WL=38%, Gs=2.67
Layer 3 CH soils, gamma s=120pcf, Wn=57%, WL=55%, Gs=2.67

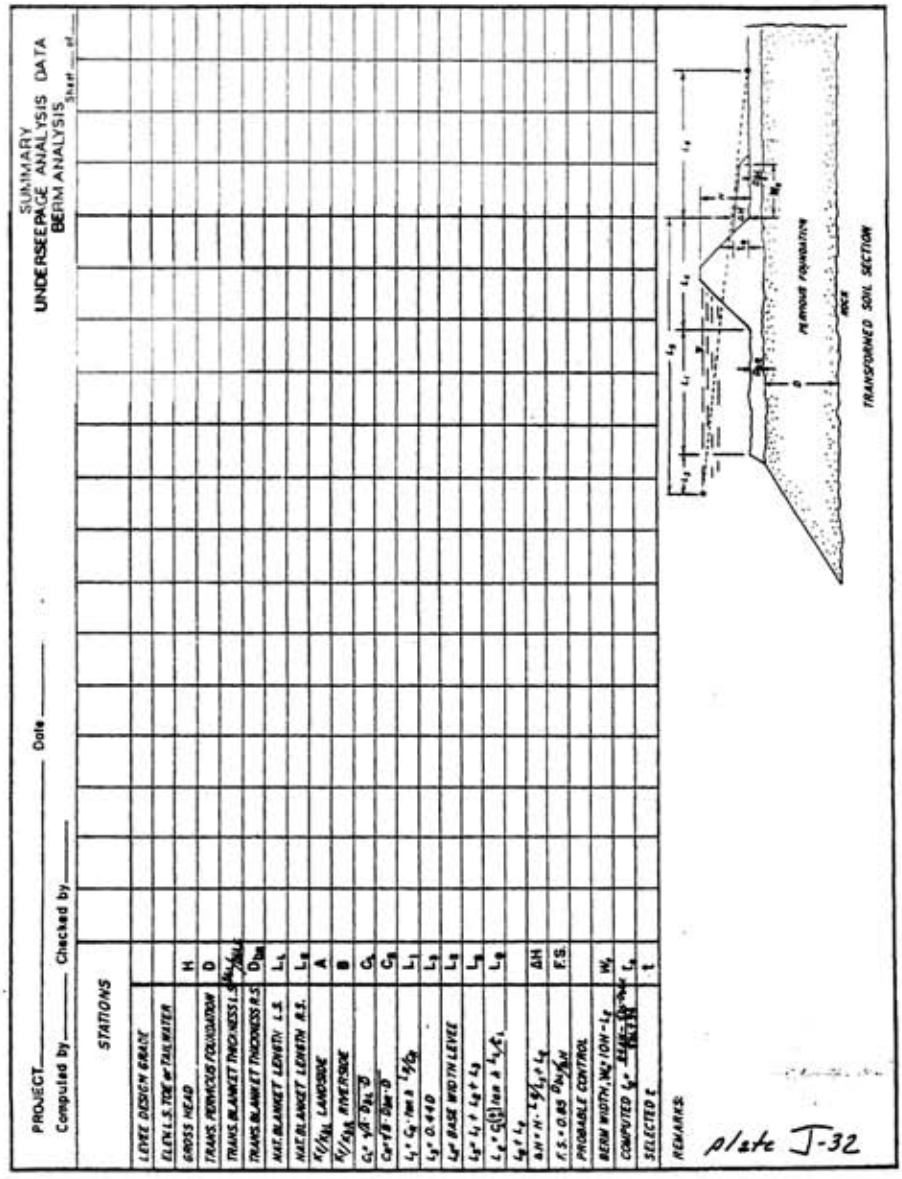
References:
1 "Foundation Analysis and Design, 3rd edition", by Joseph E. Bowles
2 "Boussinesq Coefficient from Tables of Boussinesq Coefficient for Vertical Stress Induction", published by New Orleans District, Corps of Engineers, dated March 1969

Void Ratio, eo:
0.69-0.82 range of values obtained from summary of unconsolidated undrained shear tests of similar CL soils.
1.16-1.34 range of values obtained from summary of unconsolidated undrained shear tests of similar CH soils.

Compression Index, Cc:		Totals
formula	Cc = 0.37 (eo + 0.003 x WL + 0.0004 x Wn - 0.34)	
Layer 1	Cc = 0.37 (0.750 + 0.003 x 38 + 0.0004 x 30 - 0.34) =	0.198320
Layer 2	Cc = 0.37 (0.750 + 0.003 x 38 + 0.0004 x 27 - 0.34) =	0.197876
Layer 3	Cc = 0.37 (1.250 + 0.003 x 55 + 0.0004 x 57 - 0.34) =	0.406186
po @ mid-depth		
formula	po = 1/2 x H x gamma moist/saturated	
Layer 1	po = 0.5 x 11.5 x 118 =	678.5
Layer 2	po = 11.5 x 118 + 0.5 x 2 x (119 - 62.5) =	1413.5
Layer 3	po = 11.5 x 118 + 2 x (119 - 62.5) + 0.5 x 2 x (120 - 62.5) =	1527.5
delta p		
formula	delta p = Boussinesq Coefficient x h x gamma moist	
Layer 1	delta p = 0.972 x 12 x 135 =	1574.64
Layer 2	delta p = 0.890 x 12 x 135 =	1441.80
Layer 3	delta p = 0.863 x 12 x 135	1398.06
delta s		
formula	delta s = (Cc/1+eo) x H x log10 ((po+delta p)/po)	
Layer 1	delta s =(0.198320/(1+0.75)) x 11.5 x log10 ((678.5+1574.64)/678.5) = 0.679	
Layer 2	delta s =(0.197876/(1+0.75)) x 2 x log10 ((1413.5+1441.80)/1413.5) = 0.069	
Layer 3	delta s =(0.406186/(1+1.25)) x 2 x log10 ((1527.5+1398.06)/1527.5) = 0.102	

TOTAL SETTLEMENT, inches = Layer 1 (8.2) + Layer 2 (0.8) + Layer 3 (1.2) = 10.2 inches

plate J-31


SUMMARY
UNDERSEEPAGE ANALYSIS DATA
BERM ANALYSIS
PROJECT
Date
Computed by
Checked by
STATIONS
LEVEE DESIGN GRADE
ELEV. L.S. TOE or TAILWATER
GROSS HEAD
TRANS. PERVIOUS FOUNDATION
TRANS. BLANKET THICKNESS L.S.
TRANS. BLANKET THICKNESS R.S.
HAT BLANKET LENGTH L.S.
HAT BLANKET LENGTH R.S.
LANDSIDE
RIVERSIDE
BASE WIDTH LEVEE
REMARKS
plate J-32
PERVIOUS FOUNDATION
TRANSFORMED SOIL SECTION

UNDERSEEPAGE AND BERM ANALYSIS FOR IMPERVIOUS LEVEES AT CENTRAL PLACE, DES MOINES RIVER, IA DMRR FEASB STDY

Project		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Station of Typical Section		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Elevation Top of Levee-Levee Design Grade		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	807
Elevation Landside Toe (Tailwater)		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	797
Gross Head	H	13	13	12.5	12	20	14	20	10
Transformed Thickness Pervious Foundation	D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10
Landside Blanket Thickness	D_{bL}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.5
Landside Blanket Cover	D_{bLc}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.5
Riverside Blanket Thickness	D_{bR}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.5
Landside Blanket Width	L_L	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10000
Riverside Blanket Width	L_R	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	700
Landside Blanket Permeability Ratio k_f/k_{bL}	A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	200
Riverside Blanket Permeability Ratio k_f/k_{bR}	B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	400
C_L = square root $A*D_{bL}*D$	C_L	79	279	166	173	84	152	118	114
C_R = square root $B*D_{bR}*D$	C_R	71	477	332	346	167	303	237	118
Entrance Condition - Open(*) or Blocked(/)		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	OPEN
$L_1 = C_R(*)$ or $(/)\tanh L_R/C_R$ Entrance	L_1	70	99	179	242	151	175	133	81
$L_3 = 0.44*D$	L_3	2	13	11	4	2	4	4	4
Base Width of Levee	L_2	88	88	65	82	130	94	130	70
$L_5 = L_1+L_2+L_3$	L_5	160	200	275	329	283	274	267	156
Exit Condition - Open(*) or Blocked(/)		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	OPEN
$L_e = C_L(*)$ or $(/)\tanh L_L/C_L$ Exit	L_e	79	279	166	173	84	152	118	114
L_5+L_e		239	479	441	502	367	425	385	270
Delta $H = H*L_e/(L_5+L_e)$	delta H	4.3	7.6	4.7	4.1	4.6	5.0	6.1	4.2
F.S. = $0.85*D_{bLc}$/delta H	F.S.	2.5	1.5	1.0	3.1	1.3	2.0	1.0	1.3
Probable Control		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Computed Berm Width, $10H-L_3$	W_{bc}	42	42	40	38	70	46	70	30
Selected Berm Width	W_{bs}	0	0	0	0	0	0	0	0
Computed to = (94*delta H - $53*D_{bLc}$)/147	t_{oc}	-1.8	0.2	1.0	-2.8	0.4	-1.0	1.4	0.4
Selected to	t_{os}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0
Sum of Slopes plus Crown Width (10 feet)		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8
Selected Control		NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Station of Typical Boring		12+05	20+98	37+80	41+95	47+03	52+30	56+99	66+02

Second Avenue — Jefferson Avenue — College Avenue — Clark Street — Forest Avenue — Indiana Avenue — University Avenue

Plate J-33

CENTRAL PLACE LEVEES
DES MOINES RIVER
DES MOINES, IOWA
TRANSFORMATION OF PERVIOUS FOUNDATION

ELEVATION	USCS SYMBOL	D10 millimeters	delta D' feet	kh cm/sec	deltaD'(kh) feet(cm/sec)	kh/kv	kv cm/sec	deltaD'/kv ft/(cm/sec)	percent passing #200 sieve
BORING D-1		**STATION 12+05**							
807.7	Ground Surface								
798.5	CL sandy embankment fill								
796.0	SM	est. 0.02	2.5	0	0	1	0.000	0	21
773.5	SM	est. 0.02	22.5	0	0	1	0.000	0	35, 44, 27
769.0	SP-SM	0.14	4.5	0.05	0.225	1	0.050	90	6
768.5	Shale								
	SUM				0.225			90	
D = square root delta D'kh * delta D'/kv =				**5**	**feet**				
kf = square root deltaD'kh / delta D'/kv =				**0.05**	**cm/sec =**	**0.10**	**feet/minute**		
BORING D-2		**STATION 20+98**							
806.7	Ground Surface								
795.0	CL sandy embankment fill								
786.5	CL impervious top stratum								
778.5	SM	est. 0.02	8.0	0	0.000	1	0.000	0	37
769.5	SP-SM	0.18	9.0	0.08	0.720	1	0.080	113	6
758.5	SW-SM	0.08	11.0	0.01	0.110	1	0.010	1100	9
757.5	Shale								
	SUM				0.830			1213	
D = square root delta D'kh * delta D'/kv =				**32**	**feet**				
kf = square root deltaD'kh / delta D'/kv =				**0.03**	**cm/sec =**	**0.05**	**feet/minute**		

plate J-34

CENTRAL PLACE LEVEES
DES MOINES RIVER
DES MOINES, IOWA
TRANSFORMATION OF PERVIOUS FOUNDATION

ELEVATION	USCS SYMBOL	D10 millimeters	delta D' feet	kh cm/sec	deltaD'(kh) feet(cm/sec)	kh/kv	kv cm/sec	deltaD'/kv ft/(cm/sec)	percent passing #200 sieve
BORING D-3		**STATION 32+00**							
808.3	Ground Surface								
792.0	CL sandy embankment fill								
789.5	CL impervious top stratum								
781.5	SP	0.17	8.0	0.07	0.56	3	0.023	348	5
776.5	SP-SM	0.13	5.0	0.04	0.20	1	0.040	125	7
771.5	SW-SM	0.09	5.0	0.02		1	0.02	250	10
768	Shale								
	SUM				0.76			723	
D = square root delta D'kh * delta D'/kv =				**23**	**feet**				
kf = square root deltaD'kh / delta D'/kv =				0.03	cm/sec =	0.06	feet/minute		
BORING D-4		**STATION 41+95**							
806.5	Ground Surface								
796.0	CL sandy and concrete rubble embankment fill								
780.5	CL and CH impervious top stratum								
773.0	SP-SM	0.08	7.5	0.01	0.075	1	0.010	750	9
772.5	Shale								
	SUM				0.075			750	
D = square root delta D'kh * delta D'/kv =				**8**	**feet**				
kf = square root deltaD'kh / delta D'/kv =				0.01	cm/sec =	0.02	feet/minute		

plate J-35

CENTRAL PLACE LEVEES
DES MOINES RIVER
DES MOINES, IOWA
TRANSFORMATION OF PERVIOUS FOUNDATION

ELEVATION	USCS SYMBOL	D10 millimeters	delta D' feet	kh cm/sec	deltaD'(kh) feet(cm/sec)	kh/kv	kv cm/sec	deltaD'/kv ft/(cm/sec)	
									percent passing #200 sieve
BORING D-5		**STATION 47+03**							
806.8	Ground Surface								
788.0	CL sandy embankment fill								
781.0	CL sandy impervious top stratum								51,55
774.0	SP-SM	est. 0.14	7.0	0.05	0.35	1	0.050	140	
772.0	Shale								
	SUM				0.35			140	
D = square root delta D'kh * delta D'/kv =				**7**	**feet**				
kf = square root deltaD'kh / delta D'/kv =				**0.05**	**cm/sec =**	**0.10**	**feet/minute**		
BORING D-6		**STATION 56+99**							
806.4	Ground Surface								
785.0	CL sandy embankment fill								
778.5	CL impervious top stratum								
775.5	SP-SM	0.12	3.0	0.04	0.120	1	0.040	75	7
772.5	SP-SM	0.16	3.0	0.06	0.180	1	0.060	50	6
769.5	SW-SM	0.29	3.0	0.18	0.540	1	0.180	17	5
766.0	Shale								
	SUM				0.840			142	
D = square root delta D'kh * delta D'/kv =				**11**	**feet**				
kf = square root deltaD'kh / delta D'/kv =				**0.08**	**cm/sec =**	**0.15**	**feet/minute**		

plate J-36

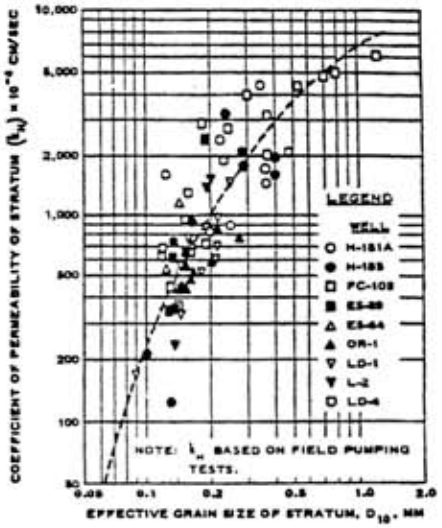
CENTRAL PLACE LEVEES
DES MOINES RIVER
DES MOINES, IOWA
TRANSFORMATION OF PERVIOUS FOUNDATION

ELEVATION	USCS SYMBOL	D10 millimeters	delta D' feet	kh cm/sec	deltaD'(kh) feet(cm/sec)	kh/kv	kv cm/sec	deltaD'/kv ft/(cm/sec)	percent passing #200 sieve
BORING D-7		**STATION 66+02**							
806.3	Ground Surface								
797.5	CL sandy embankment fill								
795.5	ML impervious top stratum								
772.5	SM	est. 0.03	23.0	0	0	1	0.000	0	36, 19, 17
767.5	SP-SM	est. 0.14	5.0	0.05	0.25	1	0.050	100	
764.5	SW-SM	0.12	3.0	0.04	0.12	1	0.040	75	8
768.0	Shale								
	SUM				0.37			175	

D = square root delta D'kh * delta D'/kv = 8 feet

kf = square root deltaD'kh / delta D'/kv = 0.05 cm/sec = 0.09 feet/minute

plate J-37



(b) Effective grain size, D_{10}, versus coefficient of permeability, k_H (from WES TM No. 3-424, ref. A-3b(2)

plate J-3B

30 April 1976

A Method to Estimate the Thickness and Width of Sand Berms for Sand Levees

		Notes*	Stations
	Elev. top of levee		
	Elev. landside toe (tailwater)		
H	Gross head		
L_2	Base width of levee	(a)	
W_o	$10H - L_2$	(b)	
D	Trans. thickness perv. found.	(c)	
L_L	Landside blanket - width	(d)	
D_{bL}	- thickness	(e)	
D_{bL_c}	- cover	(f)	
A	- perm. ratio	(g)	
C_L	$\sqrt{A \cdot D_{bL} \cdot D}$		
L_R	Riverside blanket - width	(h)	
D_{bR}	- thickness	(i)	
B	- perm. ratio	(j)	
C_R	$\sqrt{B \cdot D_{bR} \cdot D}$		
L_3	Entrance: $0.44D$	(k)	
$L_{l(o)}$	Riverside: $C_R \cdot (\tanh L_R/C_R)$ (or)	(l)	
$L_{l(x)}$	$C_R/(\tanh L_R/C_R)$	(m)	
$L_{e(o)}$	Landside: $C_L \cdot (\tanh L_L/C_L)$ (or)	(n)	
$L_{e(x)}$	$C_L/(\tanh L_L/C_L)$	(o)	
$L_s + L_e$	Total: $L_2 + L_3 + L_l + L_e$		
ΔH	$H \cdot L_e/(L_s + L_e)$		
F.S.	$(\gamma_{bL} \cdot D_{bL_c})/(\Delta H \cdot \gamma_w)$	(p)	
t_o	$(1.5\gamma_w \cdot \Delta H - D_{bL_c} \cdot \gamma_{bL})/(1.5\gamma_w + \gamma_{bL})$	(q)	
Probable Control		(r)	
t	Selected berm thickness	(s)	
W	Selected berm width	(t)	

All dimensions in feet.

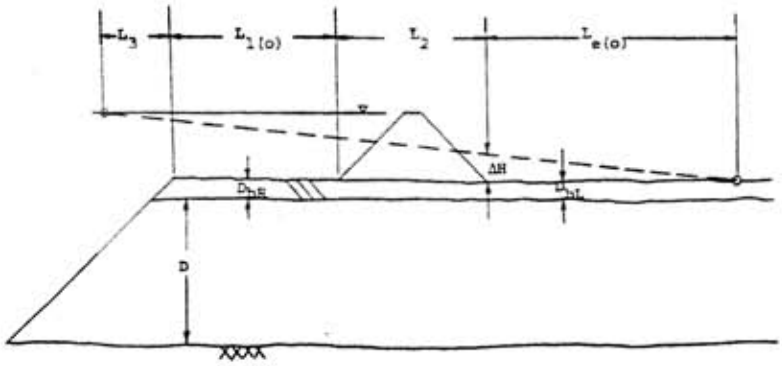
*Notes on separate sheet.

Sketch of levee and foundation configurations on separate sheet.

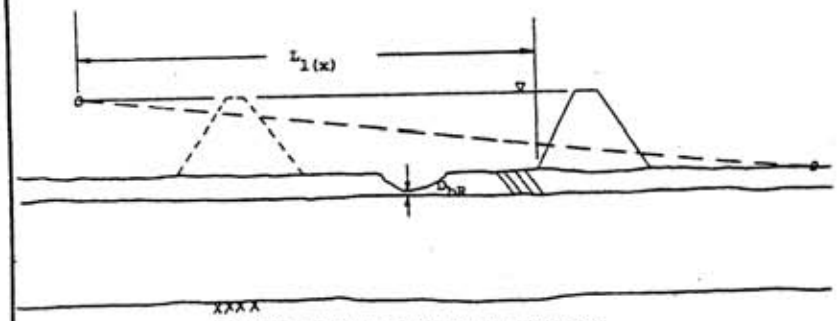
plate J-39

30 April 1976

A Method to Estimate the Thickness and Width
of Sand Berms for Sand Levees



Open entrance - Infinite L.S. blanket



Blocked entrance - Infinite L.S. blanket

TRANSFORMED SECTIONS

pl 2 to J-40

30 April 1976

A Method to Estimate the Thickness and Width of Sand Berms for Sand Levees

Notes:

(a) Measured from cross section at elev. of landside toe.

(b) Computed berm width. If base width equals or exceeds 10H no berm required.

(c) Procedure and computation on separate sheets.

(d) If L_L is less than 100 ft. provide berm and/or fill depressions to elev. of landside toe for a distance of 100 ft. beyond toe of levee or berm.

(e) If D_{bL} is zero provide berm as for (d). Transformed thickness if blanket includes semipervious soils. Use 0.5 of natural thickness for ML, 0.1 for SM, 0.0 for sand and 1.0 for impervious.

(f) Transformed thickness as for (e) except, when impervious blanket is overlain with pervious or semipervious soils, then the natural total thickness is used for the overlying soils.

(g) For D_{bL} equal to or less than 4, A = 100: for D_{bL} equal to or greater than 5, A = 200, = K_z/K_{bL}.

(h) For parallel diversion levees with blocked entrance, use 1/2 distance between riverside toes of levees.

(i) Transformed thickness as for (e).

(j) For D_{bR} equal to or less than 4, B = 400: for D_{bR} equal to or greater than 5, B = 800, = K_z/K_{bR}.

(k) For parallel diversion levees with clay in thalweg, use L_3 = 0.

(l) Use $L_{1(o)}$ for an open (o) entrance.

(m) Use $L_{1(x)}$ for blocked (x) entrance.

(n) Use $L_{e(o)}$ for finite open (o) exit or infinite blanket.

(o) Use $L_{e(x)}$ for blocked (x) exit.

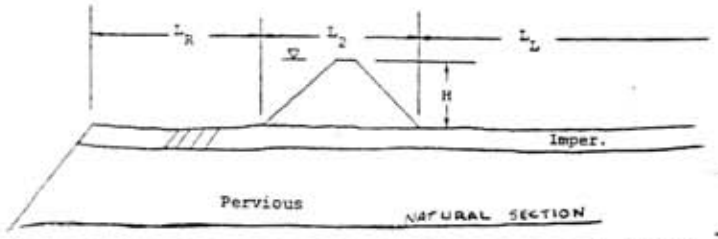
(p) γ_{bL} is submerged unit weight of landside blanket cover and berm (use 53 p.c.f.). γ_w is 62.4 p.c.f.

(q) Computed berm thickness for a factor of safety of 1.5 at landside toe of levee.

(r) For factor of safety computed at the landside toe of the levee, a berm is not required if F.S. greater than 1.5. Berm required if F.S. is equal to or less than 1.0. If F.S. greater than 1.0 and less than 1.5, and if computed berm thickness (q) is greater than 2.0, berm required. If F.S. greater than 1.0 and less than 1.5, and if computed berm thickness (q) is less than 2.0, judgement will determine whether a berm is required.

(s) Minimum 3.0 ft.

(t) Minimum 30 ft.



NATURAL SECTION

plate J-41

30 April 1976

Procedure for Transformation of Pervious Foundation

$$D = \sqrt{\Sigma(d_{(n)} K_{h(n)}) \; \Sigma \; (d_{(n)}/K_{v(n)})}$$

$$K_f = \sqrt{\Sigma(d_{(n)} K_{h(n)})/\Sigma \; (d_{(n)}/K_{v(n)})}$$

where

d (1,2,3....n) = increment (1,2,3....n) of depth of pervious strata

K_h (1,2,3....n) = horizontal permeability for corresponding increment (1,2,3....n) of pervious strata*

K_v (1,2,3....n) = vertical permeability for corresponding increment (1,2,3....n) of pervious strata

K_h (1,2,3....n)/K_v (1,2,3....n) = 1 if $D_{10} > 0.30$

= 2 if $0.20 < D_{10} \leq 0.30$

= 3 if $D_{10} < 0.20$

*The value of K_h is estimated from the D_{10} size and the graph shown in Transactions of A.S.C.E., Vol. 126, 1961, Part 1, p. 1449, Figure 12.

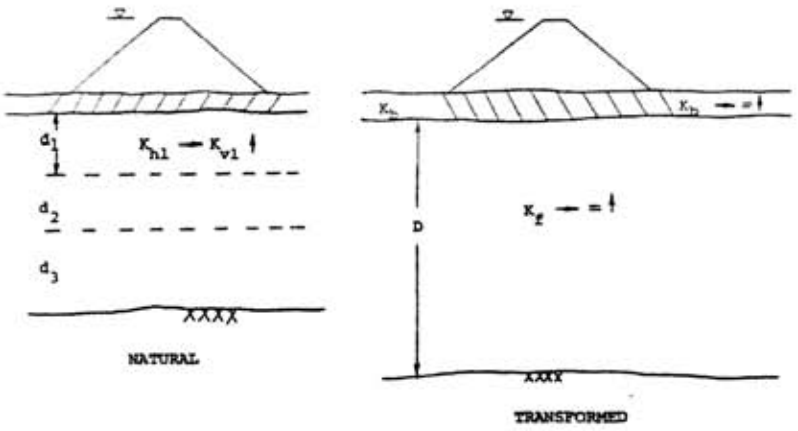


plate J-12

1000	1500	5	239	0.10	13	500	0.020921	101.71548	0.203431	0.015649
1500	2900	30	479	0.05	13	1400	0.062630	426.31315	0.304509	0.023424
2900	4000	25	441	0.06	12.5	1100	0.056689	349.82993	0.318027	0.025442
4000	4400	10	502	0.02	12	400	0.019920	14.30438	0.035761	0.002980
4400	5000	5	367	0.10	20	600	0.013624	122.28883	0.203815	0.010191
5000	5400	10	425	0.125	14	400	0.023529	123.20000	0.308000	0.022000
5400	6300	10	385	0.15	20	900	0.025974	524.57143	0.582857	0.029143
6300	6800	10	270	0.09	10	500	0.037037	124.66667	0.249333	0.024933
Start Sta. lineal feet	Finish Sta lineal feet	D feet	Ls+Le feet	kf feet/min	H feet	Reach Length lineal feet	D/Ls+Le ft/ft	See Note a) gpm/reach	See Note b) gpm/lin ft	See Note c) gpm/ft/ft
					14.4569 avg head	5800 total lin ft		1786.8899 total gpm		

0.021311 average gallons per minute per feet of head per lineal feet of levee

NOTES: a) (D/Ls+Le) *kf*H*Reach Length*7.48
b) Note a)/Reach Length
c) Note b/H

Seepage Quantities in accordance with EM 1110-2-1913 Design and Construction of levees 31 MAR 78

General Levee Alignment Condition
Case 7 - Semipervious top strata both riverside and landside
Seepage per unit length of levee,
Qs = $kfH Equation B-11, Page B-12

$ = d/(X1+L2+X3) Equation B-25, Page B-17 or

$ = D/((L1+L3)+L2) = Le = D/Ls+Le RID Nomenclature

kf = Average transformed horizontal permeability

H = Head from design levee grade

38307

629

Terracon
600 SW 7th St, Ste M
Des Moines, IA 50309
(515) 244-3184 Fax: (515) 244-6249

June 11, 2002

Missman Stanley Consultants, Inc
1011 – 27th Avenue
Rock Island, IL 61201

Attention: Mr. Michael McCaw

Re: Subsurface Exploration
Central Place Levees
Des Moines, Iowa
Project No. 08025042

Dear Mr. McCaw:

In accordance with our proposal dated May 1, 2002, we have completed the borings and laboratory testing. Attached are the boring logs, laboratory test results and subsurface profile. Below is a summary of our drilling, sampling and laboratory testing procedures.

Field Exploration

The boring locations were selected and laid out by the Corps of Engineers (COE). The ground surface elevations indicated on the boring logs were provided by the COE and are referenced to the National Vertical Geodetic Datum (NVGD).

The borings were drilled using either a truck-mounted or ATV rotary drill rig using continuous flight hollow-stemmed augers to advance the boreholes. Samples of the soil materials encountered in the borings were obtained using thin-walled and split-barrel sampling procedures in accordance with the appropriate ASTM procedures. In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (N). This value is used to estimate the in-situ relative density of cohesionless soils and the consistency of cohesive soils. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge is pushed hydraulically into the ground to obtain relatively undisturbed samples of cohesive or moderately cohesive soils. In addition, bulk samples were obtained from Borings 8 and 9. All of the samples obtained from the borings were tagged for identification, sealed, and returned to the laboratory for classification and testing.

An automatic SPT hammer was used to advance the split-barrel sampler in the borings performed. A greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable affect on the standard penetration resistance blow count (N) values.

Field logs of each boring were prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions

between samples. Final boring logs included with this report represent an interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

Laboratory Testing

Water content tests were performed on all soil samples. Unconfined compressive strength and unit weight tests were performed on suitable cohesive samples. Hand penetrometer tests were performed on relatively cohesive soil samples. The hand penetrometer is a device which has been correlated with laboratory unconfined compressive strength and provides an estimate of the strength and consistency of the soil sample. In addition, a standard Proctor, Atterberg limits tests, 200 wash and specific gravity tests were performed on a composite bulk sample obtained from Borings 8 and 9. Atterberg Limits tests and washed gradation analyses were performed on selected soil samples. Results of these laboratory tests are provided on the boring logs and attached sheets.

The samples were classified in the laboratory based on visual observation, texture and plasticity. The descriptions of the soils indicated on the boring logs are in general accordance with the enclosed General Notes and the Unified Soil Classification System. Estimated group symbols according to the Unified Soil Classification System are given on the boring logs. A brief description of this classification system is attached to this report.

We appreciate the opportunity to continually serve to you on this project. Should you have any questions concerning the contents of this letter, or if we may be of further service to you, please contact us.

Sincerely,
Terracon

Charles A. Skouby, P.E.
Project Engineer

RWGCAS/tnh

Attachments
Boring Logs
Proctor Test Results
Sieve Analyses
General Notes
Unified Soil Classification System

LOG OF BORING NO. 1

Page 1 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

Approx. Surface Elev.: 807.70 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	ATTERBERG LIMITS TEST RESULTS PERCENT
	(FILL) SANDY LEAN CLAY, TRACE GRAVEL Dark Brown and Brown				HS						
				1	ST	15		16		3130	
				2	HS ST	18		14			LL=41 PL=22 PI=19
	6.5 / 801	5									
	(FILL) VERY SANDY LEAN CLAY, TRACE GRAVEL Dark Brown			3	HS ST	12		11	119		LL=32 PL=20 PI=12
	9 / 798.5										
	(FILL) SILTY SAND, WITH GRAVEL AND ORGANICS Dark Brown			4	HS ST	10		44			
	11.5 / 796	10									
	SILTY SAND Brown Loose		SM	5	HS ST	10		17			
			SM	6	HS SS	16	3	15			
		15			HS						
			SM	7	SS	18	3	26			
		20			HS						
			SM	8	SS	18	2	33			
	26 / 781.5	25			HS						
	SILTY SAND Brown Medium Dense		SM	9	SS	19	18	22			
		30			HS						

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft				
WL	▽ 19	WD	▽ 18	AB
WL	▽		▽	
WL				

Terracon

BORING STARTED	5-20-02		
BORING COMPLETED	5-20-02		
RIG	84	FOREMAN	JG
APPROVED	CAS	JOB #	08025042

BOREHOLE 99 2502.GPJ TERRACON.GDT 8/11/02

LOG OF BORING NO. 1

Page 2 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	ATTERBERG LIMITS TEST RESULTS PERCENT
	34 773.5										
	POORLY GRADED SAND WITH SILT Brown Medium Dense	35	SP-SM	10	SS	12	15	19			
					HS						
	38 769.5 38.4 COBBLES 769 39.4 **SHALE*** 768.5 Gray			11	SS	5	50/5"				
	BOTTOM OF BORING ***Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft

WL	▽ 19	WD	▽ 18	AB
WL	▽		▽	
WL				

Terracon

BORING STARTED	5-20-02		
BORING COMPLETED	5-20-02		
RIG	84	FOREMAN	JG
APPROVED	CAS	JOB #	08025042

LOG OF BORING NO. 2

Page 1 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	ATTERBERG LIMITS TEST RESULTS PERCENT
	Approx. Surface Elev.: 806.68 ft										
	(FILL) SANDY LEAN CLAY, TRACE GRAVEL AND BRICK FRAGMENTS Dark Brown				HS						
				1	ST	15		17	118		
					HS						
		5		2	ST	14		15	121	6120	LL=35 PL=21 PI=14
					HS						
				3	ST	15		20	100		LL=35 PL=22 PI=13
					HS						
		10		4	ST	16		19			
	11.5 794.5				HS						
	LEAN CLAY, TRACE SAND Gray Stiff		CL	5	ST	18		25	105	3500*	LL=42 PL=23 PI=19
	14 792.5				HS						
	LEAN CLAY, TRACE SAND Gray Medium to Stiff	15	CL	6	ST	18		25	92	3500*	
					HS						
			CL	7	ST	16		30	90	1040	
	▽ 786.5				HS						
	20	20	CL SM	8	ST	8		19 30			
	SILTY SAND Gray Loose to Medium Dense				HS						
		25	SM	9	SS	12	5	29			
					HS						
	28 778.5										
	POORLY GRADED SAND WITH SILT Gray Dense	30	SP-SM	10	SS	8	10	20			
					HS						

Continued Next Page

The classification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft

WL ▽	20	WD ▽ 19	AB
WL ▽		▽	
WL			

Terracon

BORING STARTED			5-20-02
BORING COMPLETED			5-20-02
RIG	84	FOREMAN	JG
APPROVED	CAS	JOB #	08025042

LOG OF BORING NO. 2

Page 2 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

GRAPHIC LOG	DESCRIPTION	DEPTH, ft	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	TESTS ATTERBERG LIMITS TEST RESULTS PERCENT
	POORLY GRADED SAND WITH SILT Gray Dense										
		35	SP-SM	11	SS	16	23	16			
					HS						
	37 769.5										
	WELL GRADED SAND WITH SILT Gray Dense										
		40	SW-SM	12	SS	16	30	14			
					HS						
		45	SW-SM	13	SS	14	25	16			
					HS						
	48 758.5										
	SHALE*** 49.2 Gray 757.5			14	SS	3	50/3"	11			
	BOTTOM OF BORING ***Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft

WL	▽ 20	WD	▼ 19	AB
WL	▽		▼	
WL				

Terracon

BORING STARTED	5-20-02		
BORING COMPLETED	5-20-02		
RIG	84	FOREMAN	JG
APPROVED	CAS	JOB #	08025042

LOG OF BORING NO. 3

Page 1 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	ATTERBERG LIMITS TEST RESULTS PERCENT
	Approx. Surface Elev.: 808.30 ft										
	(FILL) SANDY LEAN CLAY, TRACE GRAVEL Dark Brown and Brown				HS						
				1	ST	9		17	116	5960	LL=33 PL=17 PI=16
		5		2	HS ST	15		15 10		5000*	
				3	HS ST	8		15	115	9000*	LL=38 PL=18 PI=20
		10		4	HS ST	12		18	100	5220	LL=37 PL=25 PI=12
				5	HS ST	10		20	91	6000*	
	16.5 792	15		6	HS ST	22		24	91	1900	
	LEAN CLAY Brown Stiff		CL	7	HS ST	8		15	101	3130	LL=46 PL=25 PI=21
	19 ▽ 789.5 POORLY GRADED SAND Brown Loose	20	SP	8	HS SS	16	6	21			
					HS						
		25	SP	9	SS	8	8	24			
	27 781.5				HS						
	POORLY GRADED SAND WITH SILT Brown Medium Dense		SP-SM	10	SS	8	19	19			
	32 776.5	30			HS						
	Continued Next Page										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 19	WD	▽
WL	▽		▽
WL	Cl @ 19' AB		

Terracon

BORING STARTED	5-17-02		
BORING COMPLETED	5-17-02		
RIG	84	FOREMAN	JG
APPROVED	CAS	JOB #	08025042

LOG OF BORING NO. 3

Page 2 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	ATTERBERG LIMITS TEST RESULTS PERCENT
	WELL GRADED SAND WITH SILT Brown Dense	35	SW-SM	11	SS	18	40	10			
	37 771.5				HS						
	SHALE*** Dark Gray	40		12	SS	18	44	17			
	40.5 768 BOTTOM OF BORING ***Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 19	WD	▼
WL	▽		▼
WL	CI @ 19' AB		

Terracon

BORING STARTED	5-17-02		
BORING COMPLETED	5-17-02		
RIG	84	FOREMAN:	JG
APPROVED	CAS	JOB #	08025042

LOG OF BORING NO. 4

Page 1 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

Approx. Surface Elev.: 806.51 ft

Depth, ft.	Description	Elev.	USCS Symbol	Number	Type	Recovery, in.	SPT - N Blows / ft.	Water Content, %	Dry Unit Wt pcf	Unconfined Strength, psf	Atterberg Limits Test Results Percent
1	(FILL) LEAN CLAY, TRACE SAND Dark Brown	805.5			HS						
	(FILL) SANDY LEAN CLAY Dark Brown and Brown			1	ST	11		16	116	4670	LL=37 PL=16 PI=21
5				2	HS ST	10		14		9000*	
6.5	(FILL) CONCRETE RUBBLE	800		3	HS ST	NR					
				4	HS SS	6	14	12			
10.5	LEAN CLAY, TRACE SAND Brown Medium to Very Stiff	796			HS						
			CL	5	ST	11		22	109	4580	LL=40 PL=24 PI=16
15			CL	6	HS ST	10		22	105	3770	LL=35 PL=24 PI=11
			CL	7	HS ST	13		29	92	1000	
20			CL	8	HS ST	13		31	90	1040	
22	LEAN CLAY Gray, Medium	▽ 784.5	CL	9	HS ST	12		27	94	1650	
24	FAT CLAY, TRACE SAND Gray, Medium	782.5	CH	10	HS SS	18	3	57		1000*	LL=55 PL=28 PI=27
26	POORLY GRADED SAND WITH SILT Gray Loose to Medium Dense	780.5			HS						
30			SP-SM	11	SS	12	14	22			
					HS						

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 22	WD	▼
WL	▼		▼
WL	CI @ 20' AB		

Terracon

BORING STARTED	5-17-02		
BORING COMPLETED	5-17-02		
RIG	84	FOREMAN	JG
APPROVED	CAS	JOB #	08025042

BOREHOLE 99 2042 GPJ TERRACON.GDT 6/11/02

LOG OF BORING NO. 4

Page 2 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf	TESTS: ATTERBERG LIMITS TEST RESULTS PERCENT
	33.5 772										
	34.2 SHALE*** 772.5 Dark Gray										
	13 SS 3 50/3" 19										
	BOTTOM OF BORING ***Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft

WL ▽ 22 WD ▽

WL ▽ ▽

WL CI @ 20' AB

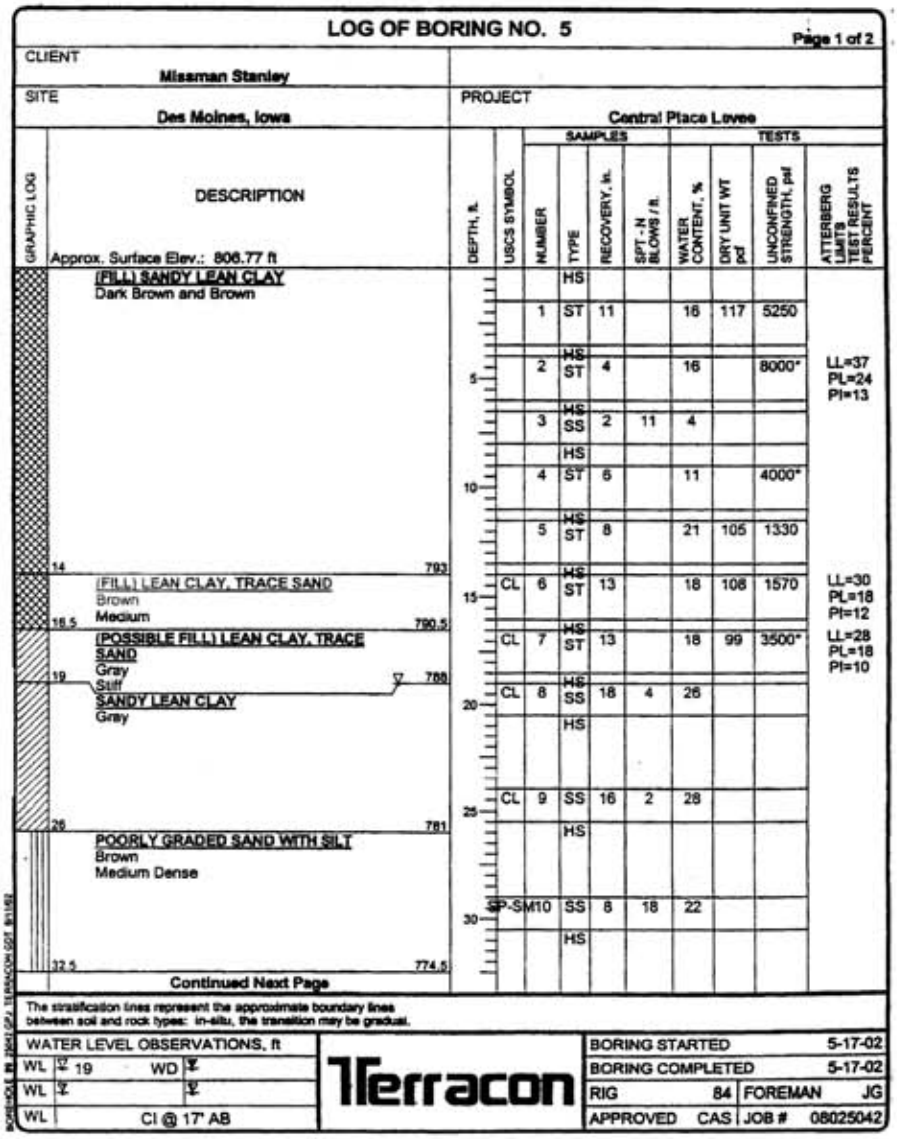
Terracon

BORING STARTED 5-17-02

BORING COMPLETED 5-17-02

RIG 84 FOREMAN JG

APPROVED CAS JOB # 08025042



LOG OF BORING NO. 5

Page 1 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

DESCRIPTION (Approx. Surface Elev.: 806.77 ft)	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf	ATTERBERG LIMITS TEST RESULTS PERCENT
(FILL) SANDY LEAN CLAY Dark Brown and Brown				HS						
			1	ST	11		16	117	5250	
			2	HS ST	4		16		8000*	LL=37 PL=24 PI=13
	5		3	HS SS	2	11	4			
				HS						
			4	ST	6		11		4000*	
	10		5	HS ST	8		21	105	1330	
14 793										
(FILL) LEAN CLAY, TRACE SAND Brown Medium		CL	6	HS ST	13		18	108	1570	LL=30 PL=18 PI=12
18.5 790.5	15									
(POSSIBLE FILL) LEAN CLAY, TRACE SAND Gray Stiff		CL	7	HS ST	13		18	99	3500*	LL=28 PL=18 PI=10
19 788 ▽										
SANDY LEAN CLAY Gray		CL	8	HS SS	18	4	26			
	20			HS						
		CL	9	SS	16	2	28			
26 781	25									
POORLY GRADED SAND WITH SILT Brown Medium Dense				HS						
		SP-SM	10	SS	8	18	22			
	30			HS						
32.5 774.5										

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft

WL ▽ 19 WD ▽

WL ▽ ▽

WL CI @ 17' AB

Terracon

BORING STARTED 5-17-02

BORING COMPLETED 5-17-02

RIG 84 FOREMAN JG

APPROVED CAS JOB # 08025042

LOG OF BORING NO. 5

Page 2 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	TESTS ATTERBERG LIMITS TEST RESULTS PERCENT
	33 COBBLES 774										
	SHALE***										
	34.9 Dark Gray 772			11	SS	11	50/5"	15			
	BOTTOM OF BORING										
	***Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft

WL ▽ 19 WD ▽

WL ▽ ▽

WL Cl @ 17' AB

Terracon

BORING STARTED	5-17-02		
BORING COMPLETED	5-17-02		
RIG	84	FOREMAN	JG
APPROVED	CAS	JOB #	08025042

LOG OF BORING NO. 6

Page 1 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	ATTERBERG LIMITS TEST RESULTS PERCENT
	Approx. Surface Elev.: 806.44 ft										
	(FILL) SANDY LEAN CLAY, TRACE GRAVEL Dark Brown and Brown				HS						
				1	ST	14		17	113	3960	LL=36 PL=19 PI=17
		5		2	HS SS	NR	5				
					HS						
				3	ST	4		21		2000*	LL=38 PL=25 PI=13
		10		4	HS ST			23		2500*	
			CL	5	HS ST	8		25	95	500*	LL=36 PL=18 PI=18
		15	CL	6	HS ST	10		29	93	1480	
	16.5 790										
	(FILL) LEAN CLAY, TRACE SAND AND SHALE Gray Brown		CL	7	HS ST	10		28	98	1470	LL=39 PL=20 PI=19
	20.5 786		CL SP	8	HS ST	15		27	98	1950	
	21.5 785 (POSSIBLE FILL) POORLY GRADED SAND Dark Gray	20	CL	9	HS SS	16	3	31		1500*	LL=41 PL=26 PI=15
	LEAN CLAY, TRACE SAND Dark Gray Stiff to Medium				HS						
		25	CL	10	SS	18	6	23		2000*	
	26.5 780				HS						
	LEAN CLAY WITH SAND SEAMS 28 Gray, Medium 778.5		CL	11	SS	18	5	29		1500*	
	POORLY GRADED SAND WITH SILT Gray Loose to Medium Dense				HS						
		30	SP-SM	12	SS	18	15	20			
					HS						
			SP-SM	13	SS	18	18	19			
	Continued Next Page										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 20	WD	▽
WL	▽		▽
WL			

Terracon

BORING STARTED	5-16-02		
BORING COMPLETED	5-16-02		
RIG	101	FOREMAN	PF
APPROVED	CAS	JOB #	08025042

LOG OF BORING NO. 6

Page 2 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	TESTS ATTERBERG LIMITS TEST RESULTS PERCENT
	24 772.5				HS						
	WELL GRADED SAND WITH GRAVEL AND SILT Brown, Medium Dense	35	SW-SM	14	SS	18	18	13			
	36.5 770 34.0 769.5 COBBLES				HS						
	SHALE Gray			15	SS HS	0	50/2"				
	40.5 766	40		16	SS	18	50	14			
	BOTTOM OF BORING ***Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft

WL	▽ 20	WD	▽
WL	▽		▽
WL			

Terracon

BORING STARTED	5-16-02		
BORING COMPLETED	5-16-02		
RIG	101	FOREMAN	PF
APPROVED	CAS	JOB #	08025042

LOG OF BORING NO. 7

Page 1 of 2

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

Approx. Surface Elev.: 806.28 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	ATTERBERG LIMITS TEST RESULTS PERCENT
	(FILL) SANDY LEAN CLAY, TRACE BRICK AND CONCRETE FRAGMENTS, Dark Brown — 805.5				HS						
				1	ST	14		15	117	6530	LL=37 PL=21 PI=16
	(FILL) SANDY LEAN CLAY, TRACE GRAVEL, Dark Brown and Brown				HS						
		5		2	ST	11		21	107	4170	
	6.5 — 800				HS						
	(FILL) LEAN CLAY, TRACE SAND, Brown			3	ST	6		20	107	5000+	LL=37 PL=23 PI=14
	9 — 797.5				HS						
	SILT, TRACE SAND, Dark Brown, Very Stiff		ML	4	ST	13		19	92		LL=28 PL=22 PI=6
	11 — ▽ 795.5	10									
	SILTY SAND, TRACE ORGANICS, Dark Brown, Loose		SM	5	HS ST	18		9			
		15	SM	6	HS SS	18	6	39			
	16.5 — 790				HS						
	SILTY SAND, Brown, Loose		SM	7	SS	18	3	27			
					HS						
		20	SM	8	SS	18	7	22			
	21.5 — 785				HS						
	SILTY SAND, Gray, Loose to Medium Dense		SM	9	SS	18	4	26			
					HS						
		25	SM	10	SS	18	10	24			
					HS						
			SM	11	SS	12	27	19			
					HS						
		30	SM	12	SS	18	5	22			
					HS						
			SM	13	SS	18	13	22			

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft

WL	▽ 11	WD	▽
WL	▽		▽
WL			

Terracon

BORING STARTED	5-16-02		
BORING COMPLETED	5-16-02		
RIG	101	FOREMAN	PF
APPROVED	CAS	JOB #	08025042

LOG OF BORING NO. 7

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf	TESTS ATTERBERG LIMITS TEST RESULTS PERCENT
	34 772.5				HS						
	POORLY GRADED SAND, WITH SILT, TRACE GRAVEL, Brown, Medium Dense	35	SP-SM	14	SS	18	14	12			
					HS						
			SP-SM	15	SS	18	22	10			
	39 767.5				HS						
	WELL GRADED SAND, WITH SILT AND GRAVEL, Brown, Dense	40	SW-SM	16	SS	18	31	10			
	41.5 765				HS						
	41.8 COBBLES 764.5										
	42.2 SHALE*** 764 Gray Weathered			17	SS	2	50/2"	12			
	BOTTOM OF BORING										

***Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 11	WD	▽
WL	▽		▽
WL			

Terracon

BORING STARTED	5-16-02		
BORING COMPLETED	5-16-02		
RIG	101	FOREMAN	PF
APPROVED	CAS	JOB #	08025042

LOG OF BORING NO. 8

Page 1 of 1

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

Approx. Surface Elev.: 790.75 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	(FILL) LEAN CLAY, TRACE BRICK FRAGMENTS Dark Brown				HS					
	3 788			1	SS	8	5	26		2000*
	SANDY LEAN CLAY Brown, Stiff				HS					
	5 786		CL	2	ST	3		28		2000*
	POORLY GRADED SAND, WITH SILT Brown Loose	5	SP-SM							
			SP-SM	3	HS SS	14	5	27		
					HS					
		10	SP-SM	4	SS	16	5	25		
					HS					
			SP-SM	5	SS	18	5	24		
	13 778									
	BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft

WL	▽ 5	WD	▽ 5	AB
WL	▽		▽	
WL				

Terracon

BORING STARTED	5-17-02
BORING COMPLETED	5-17-02
RIG 84	FOREMAN JG
APPROVED CAS	JOB # 08025042

LOG OF BORING NO. 9

Page 1 of 1

CLIENT: Missman Stanley

SITE: Des Moines, Iowa

PROJECT: Central Place Levee

Approx. Surface Elev.: 792.96 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf
	(FILL) CINDERS AND BRICK FRAGMENTS WITH SAND Dark Brown				HS					
				1	SS	12	10	22		
	4 — 789				HS					
	(FILL) BRICKS AND RUBBLE			2	SS	NR	3			
	5.5 — 787.5	5								
	SANDY LEAN CLAY Brown Soft				HS					
			CL	3	SS	18	1	26		
	8 — 785									
	POORLY GRADED SAND, WITH SILT Brown Loose				HS					
		10	SP-SM	4	SS	16	4	25		
					HS					
			SP-SM	5	SS	10	4	27		
	13 — 780									
	BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	8.5	WD	9 AB
WL			
WL			

Terracon

BORING STARTED	5-17-02		
BORING COMPLETED	5-17-02		
RIG	84	FOREMAN	JG
APPROVED	CAS	JOB #	08025042

Terracon

Laboratory Compaction Characteristics of Soil

600 SW 7th Street, Suite M
Des Moines, Iowa 50309
515-244-3184

Client Name: MISSMAN STANLEY
Project Name: CENTRAL PLACE LEVEE
Location: COMPOSITE SAMPLE FROM BORINGS 8 AND 9 OF THE NATIVE BROWN SANDY LEAN CLAY
Source Material: BORINGS 8 (3 to 5 ft.) and 9 (5.5 to 8 ft.)
Sample Description: DARK BROWN SANDY LEAN CLAY
SPECIFIC GRAVITY = 2.67
Material Designation: _____ Sample date: _____
Test Method: ASTM D-698
Test Procedure: Method A
Sample Preparation: WET
Rammer: X Mechanical ___ Manual

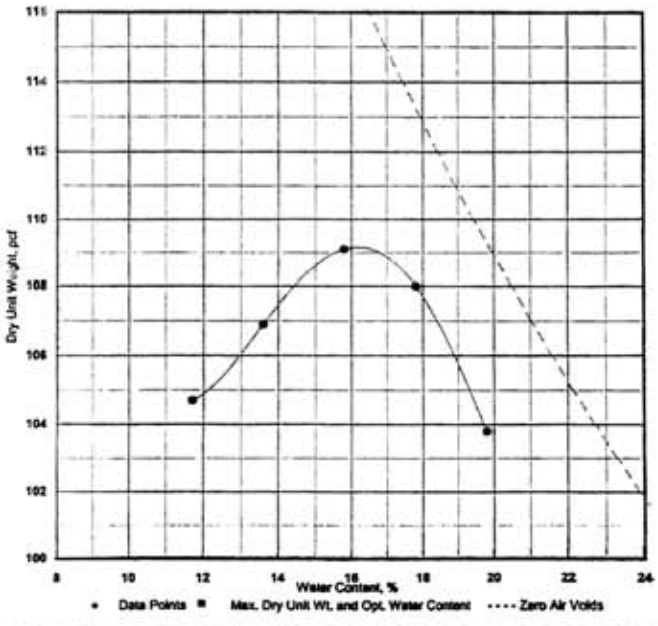
Project No.: 08025042 Date: 06/04/2002

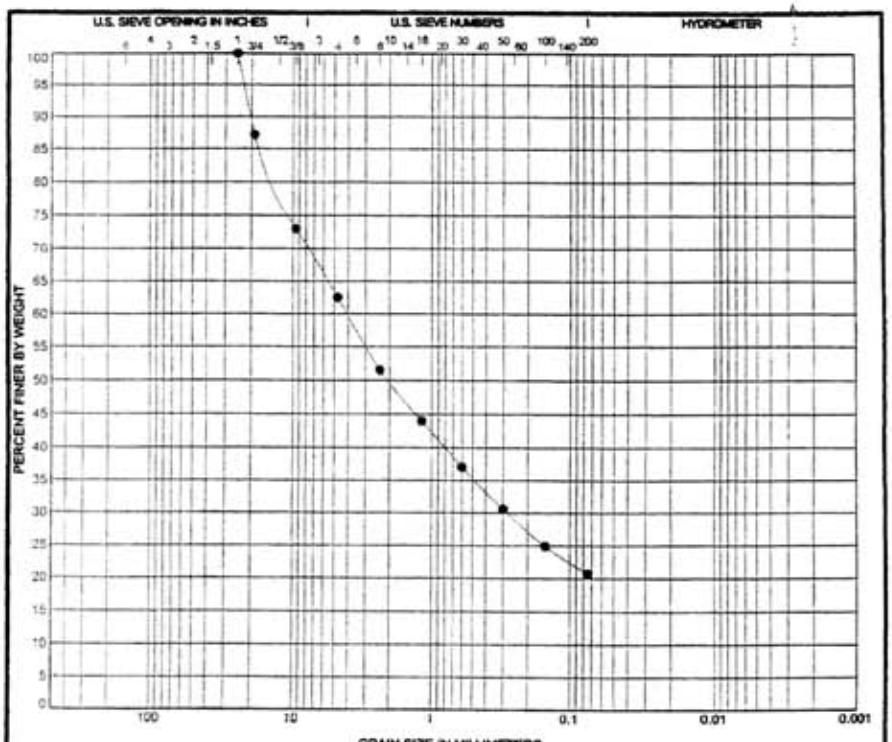
TEST RESULTS
Maximum Dry Unit Wt.: 109.2 pcf
Optimum Water Content: 16.3 %

Liquid Limit: 38 Plastic Limit: 20
Plasticity Index: 18
% passing # 200 sieve: 70

Reviewed by: PJF

Zero air voids for specific gravity of 2.68





COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 1	9ft	SILTY SAND, WITH GRAVEL AND ORGANICS (SM)					

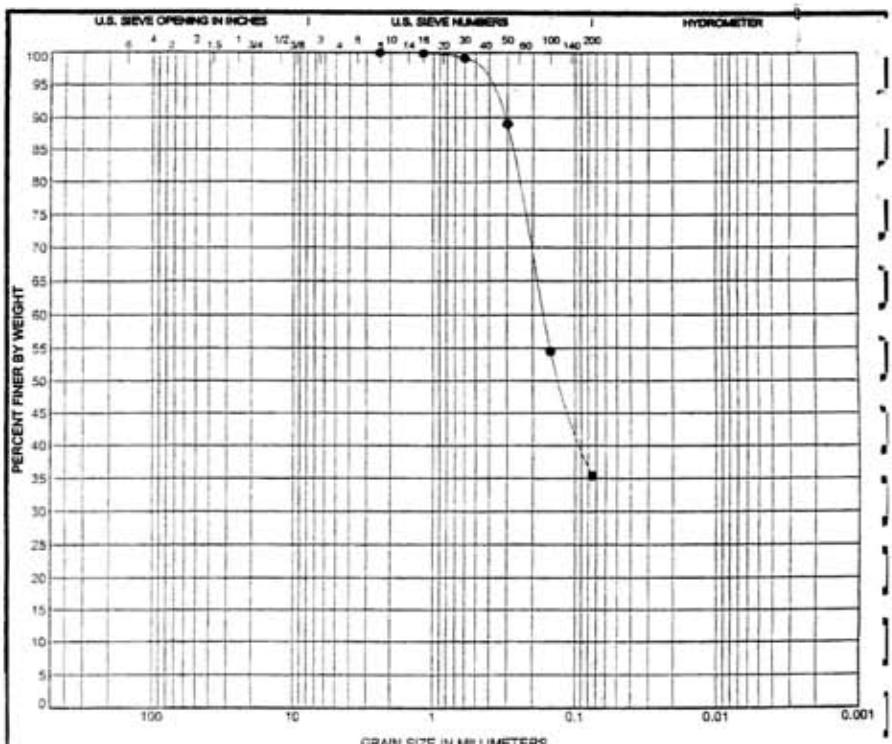
Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 1	9ft	25	4.044	0.28		37	42	21	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-11-02

TC_GRAIN SIZE 25042.GPJ_TERRACON.GDT 6/11/02



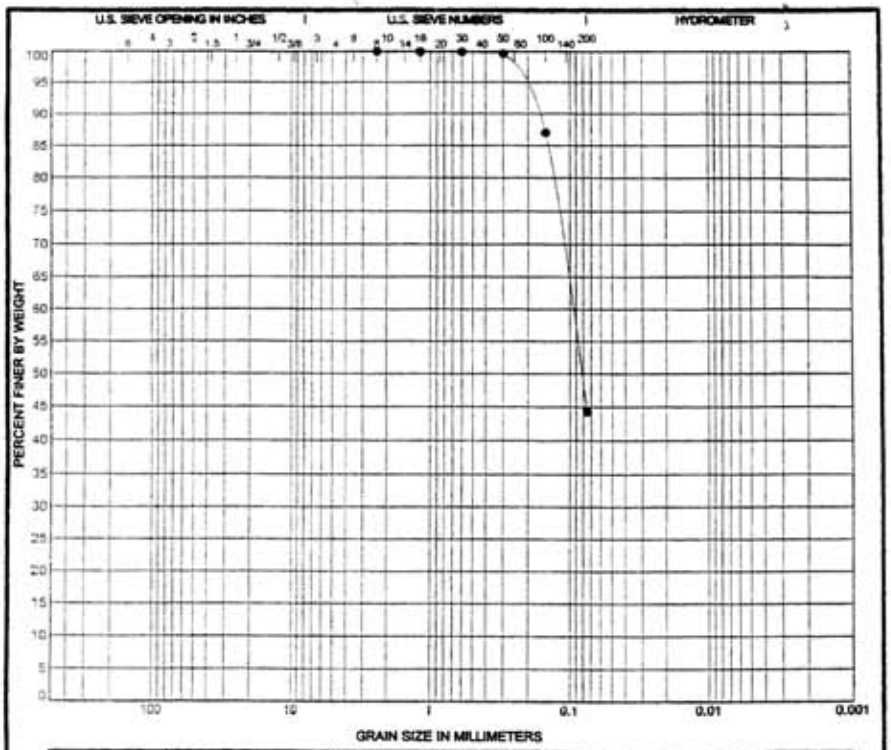
Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 1	14ft	SILTY SAND (SM)					

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 1	14ft	2.4	0.167			0	65	35	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

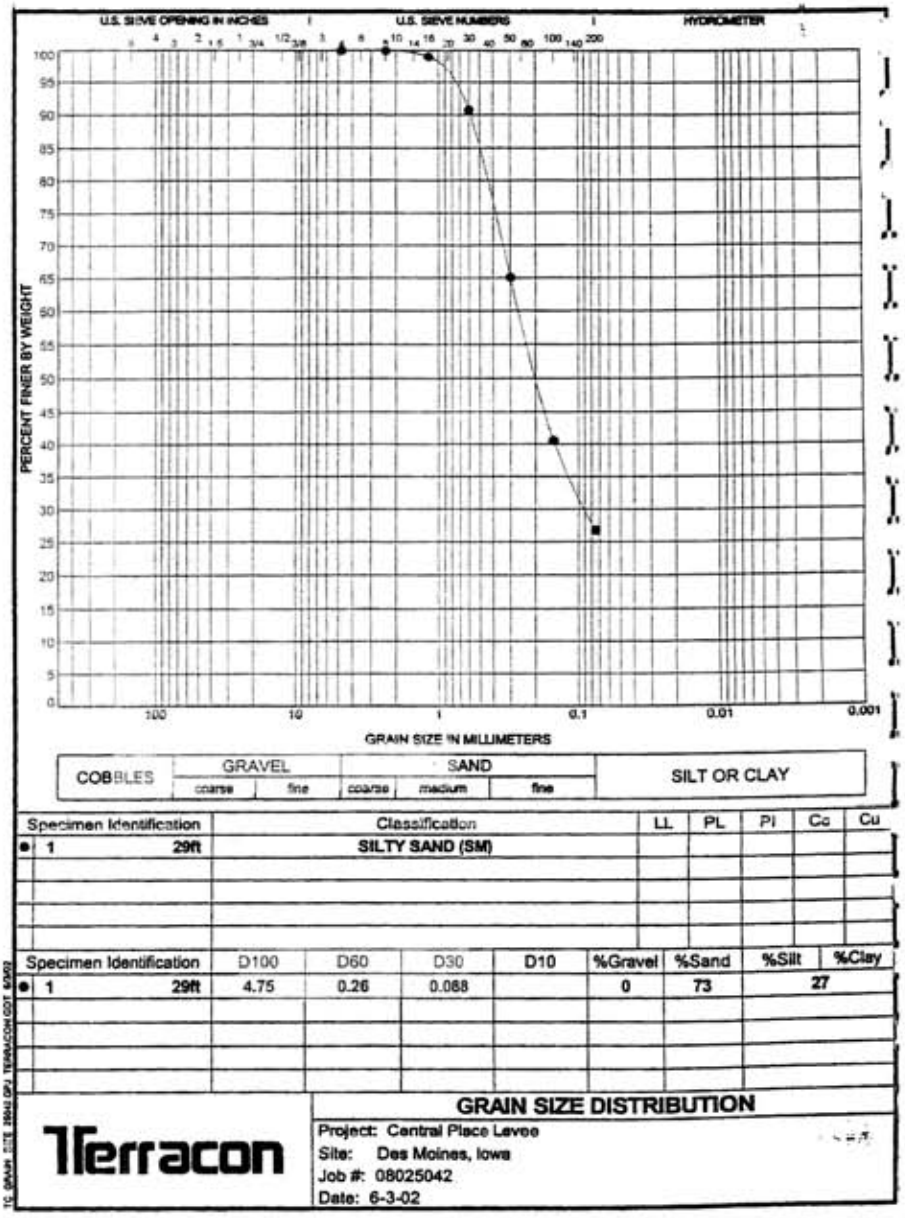
	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	1	19ft	SILTY SAND (SM)					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	1	19ft	2.36	0.097			0	56	44	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-11-02



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 1	29ft	SILTY SAND (SM)					

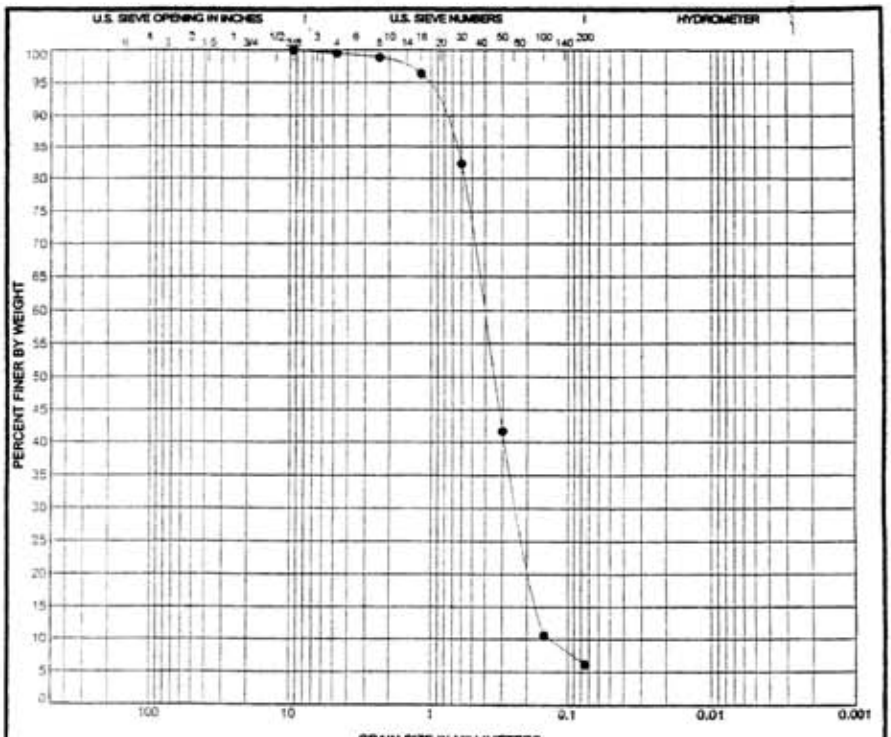
Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 1	29ft	4.75	0.26	0.088		0	73	27	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02

TC GRAIN SIZE 38643.GPJ TERRACON.GDT 6/3/02



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	1	34ft	POORLY GRADED SAND WITH SILT (SP-SM)				0.96	3.01

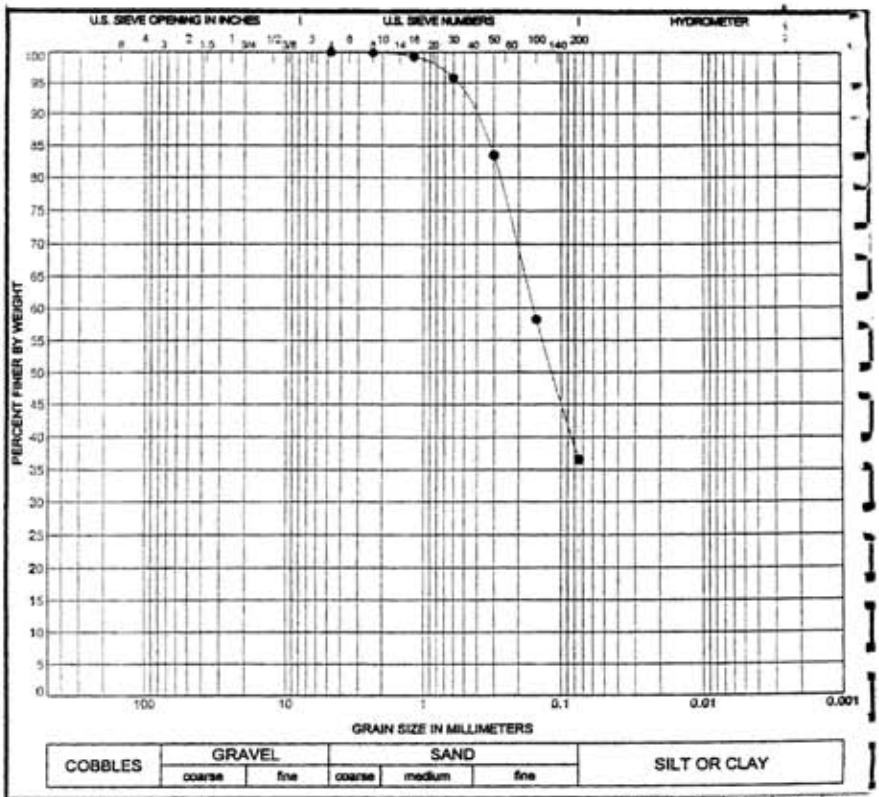
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	1	34ft	9.5	0.41	0.231	0.136	0	93	6	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-11-02

TC GRAIN SIZE 25042.GPJ TERRACON.GDT 6/11/02



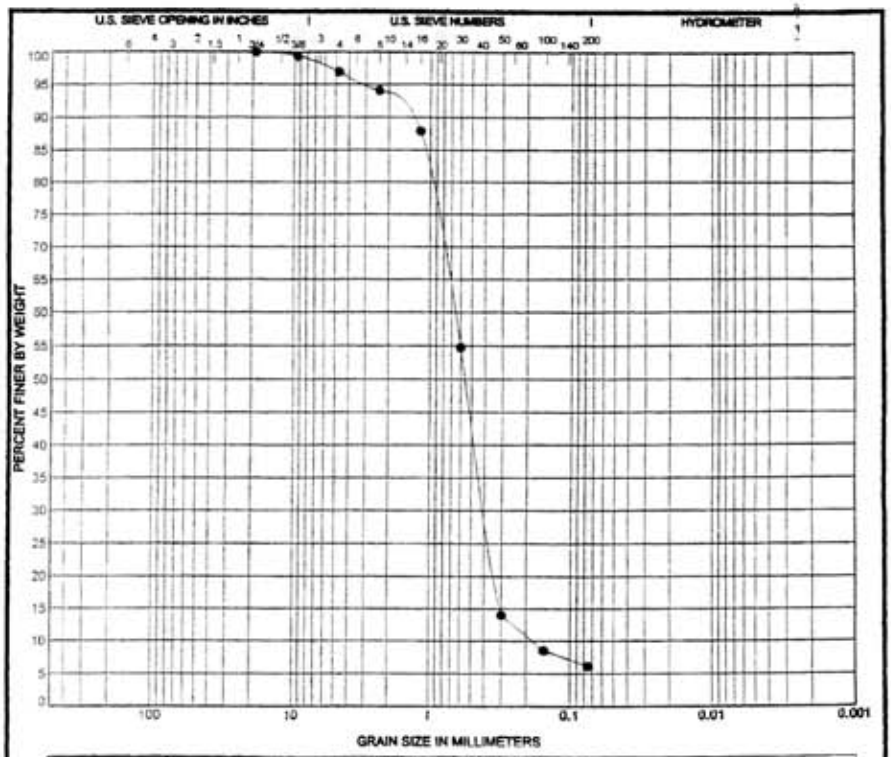
Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● 2 24ft	SILTY SAND (SM)					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 2 24ft	4.75	0.157			0	63	37	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02



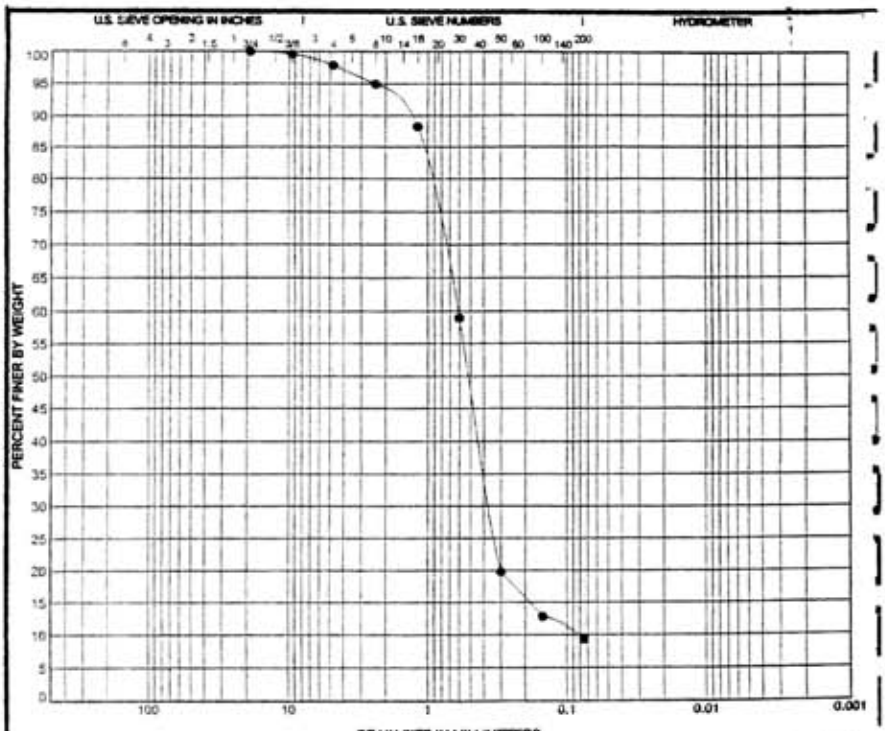
Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 2	34ft	POORLY GRADED SAND WITH SILT (SP-SM)				1.29	3.72

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 2	34ft	19	0.668	0.394	0.18	3	91	6	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

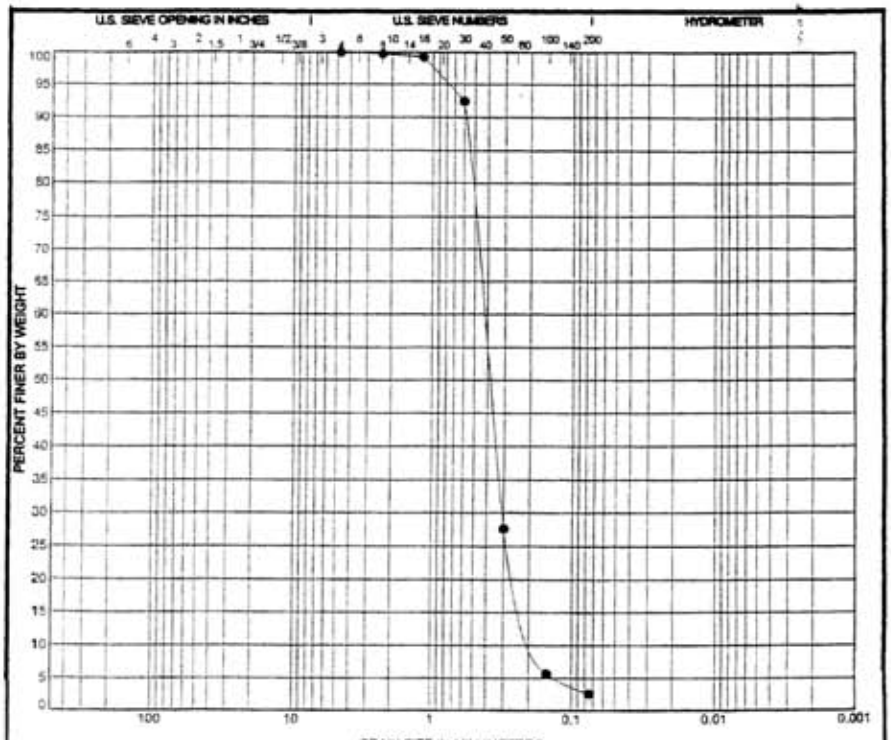
Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 2	39ft	WELL GRADED SAND WITH SILT (SW-SM)				2.50	7.29

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 2	39ft	19	0.614	0.359	0.084	2	88	9	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02



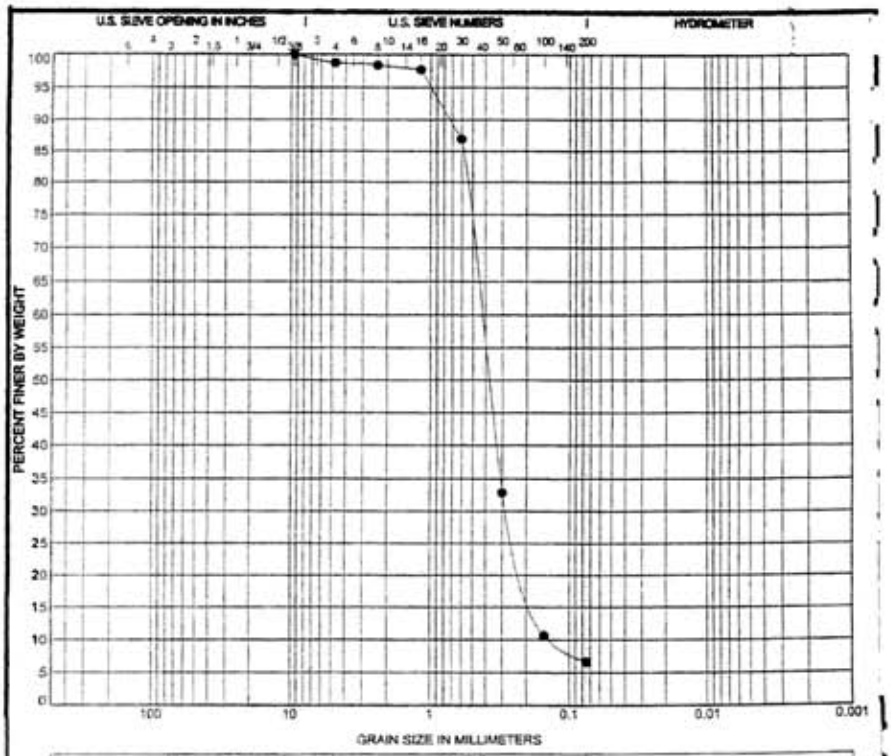
Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 3	19ft	POORLY GRADED SAND(SP)				1.30	2.47

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 3	19ft	4.75	0.424	0.308	0.172	0	97	3	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

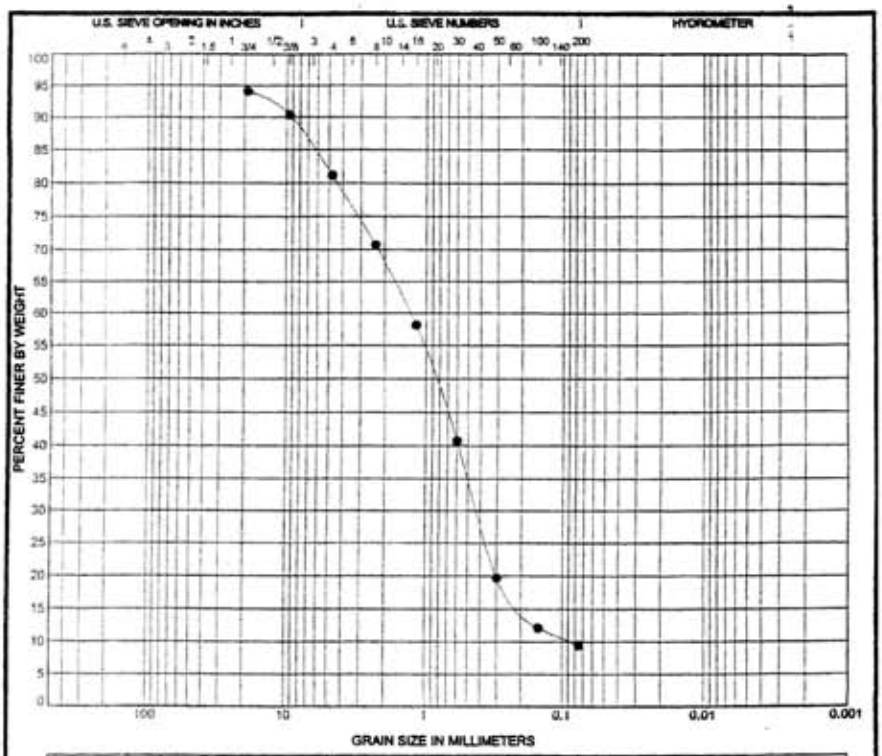
	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	3	29ft	POORLY GRADED SAND WITH SILT (SP-SM)				1.33	3.17

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	3	29ft	9.5	0.425	0.275	0.134	1	92	7	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	3 34ft	WELL GRADED SAND WITH SILT (SW-SM)				1.60	15.36

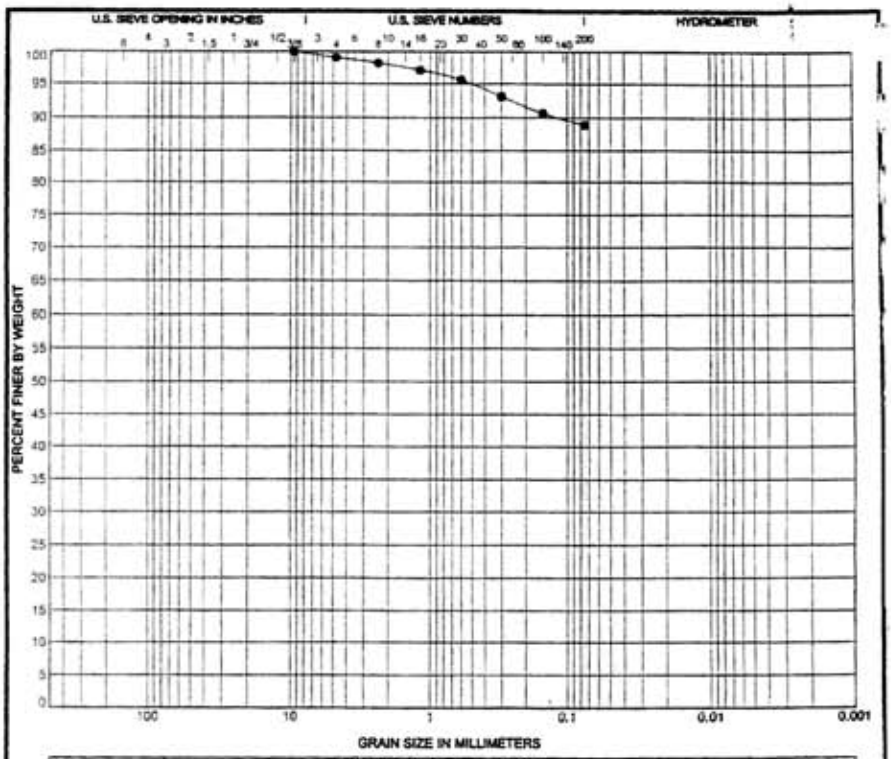
	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	3 34ft	19	1.306	0.421	0.085	13	72	10	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02

TC GRAIN SIZE 2002.GPJ TERRACON.GDT 6/3/02



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	4	21.5ft	LEAN CLAY (CL)					

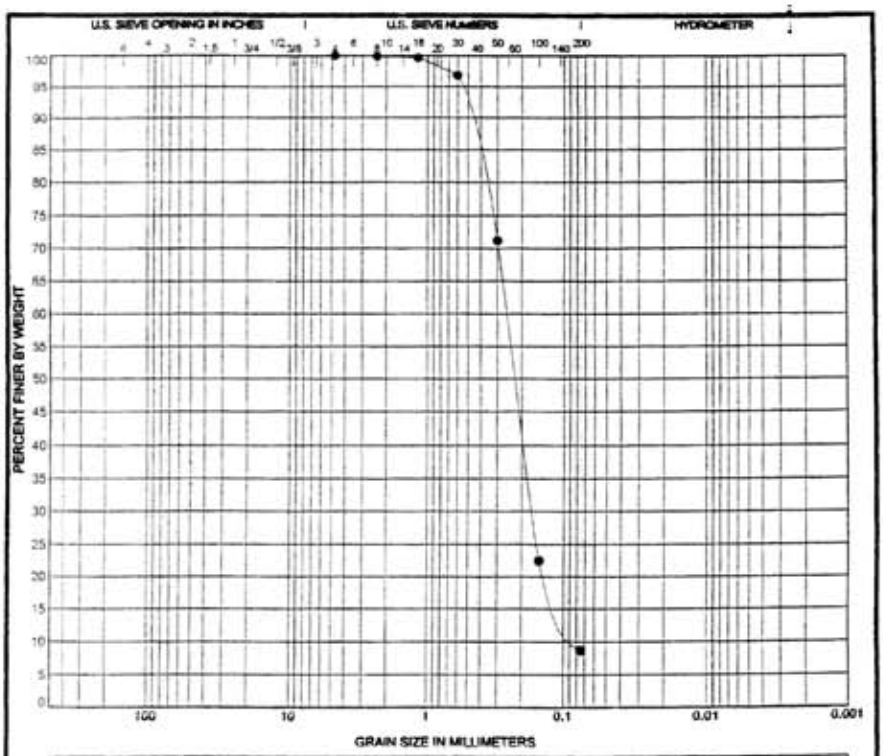
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	4	21.5ft	9.5				1	10	89	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-11-02

TC GRAIN SIZE 2003.GPJ TERRACON.GDT 6/11/02



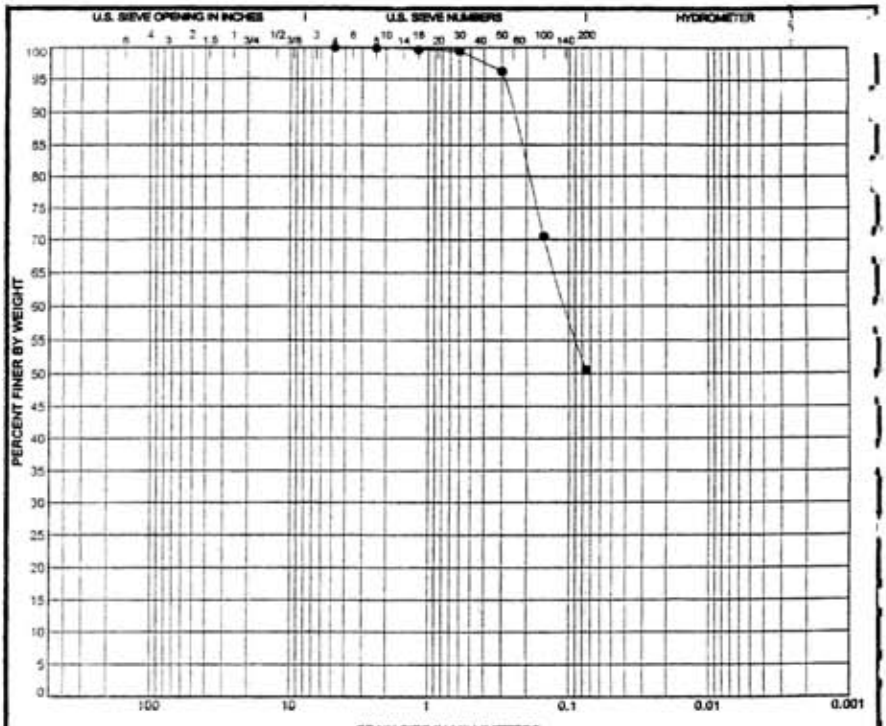
Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 4	29ft	POORLY GRADED SAND WITH SILT (SP-SM)				1.36	3.20

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 4	29ft	4.75	0.256	0.167	0.08	0	91	9	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02



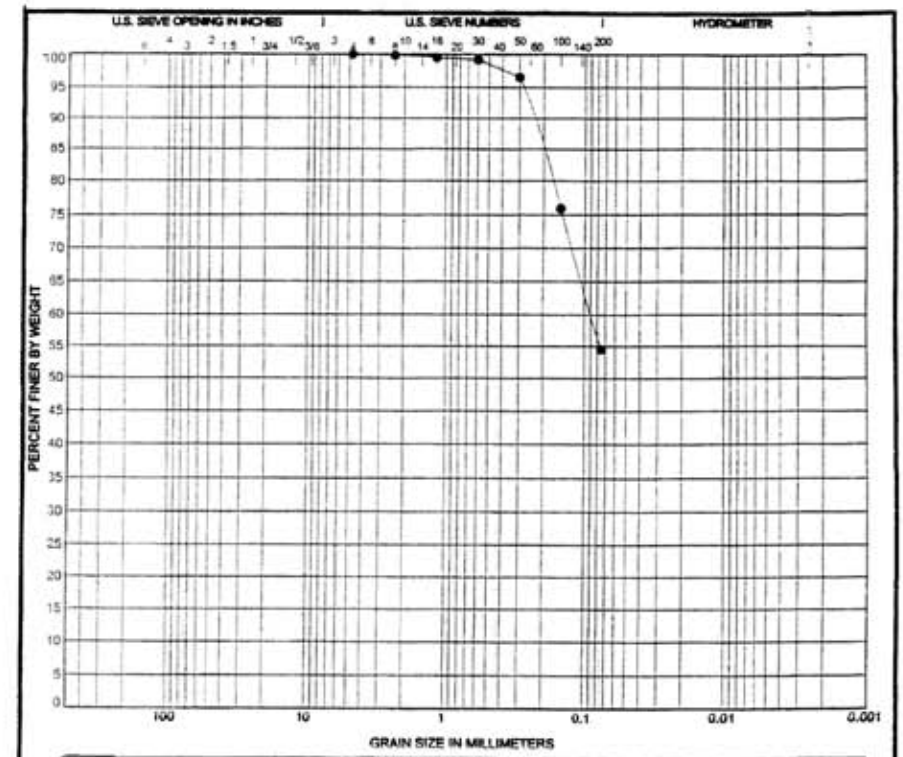
Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 5	19ft	SANDY LEAN CLAY (CL)					

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 5	19ft	4.75	0.104			0	49	51	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 5	24ft	SANDY LEAN CLAY (CL)					

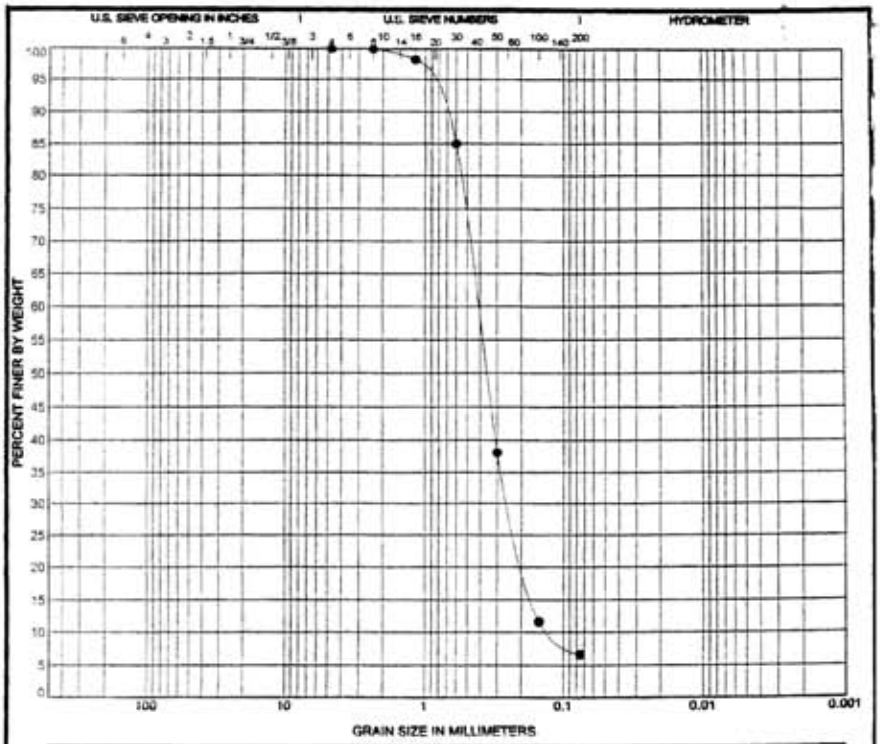
Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 5	24ft	4.75	0.09			0	45	55	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02

TC GRAIN SIZE 2004.GPJ TERRACON.GDT 8/3/02



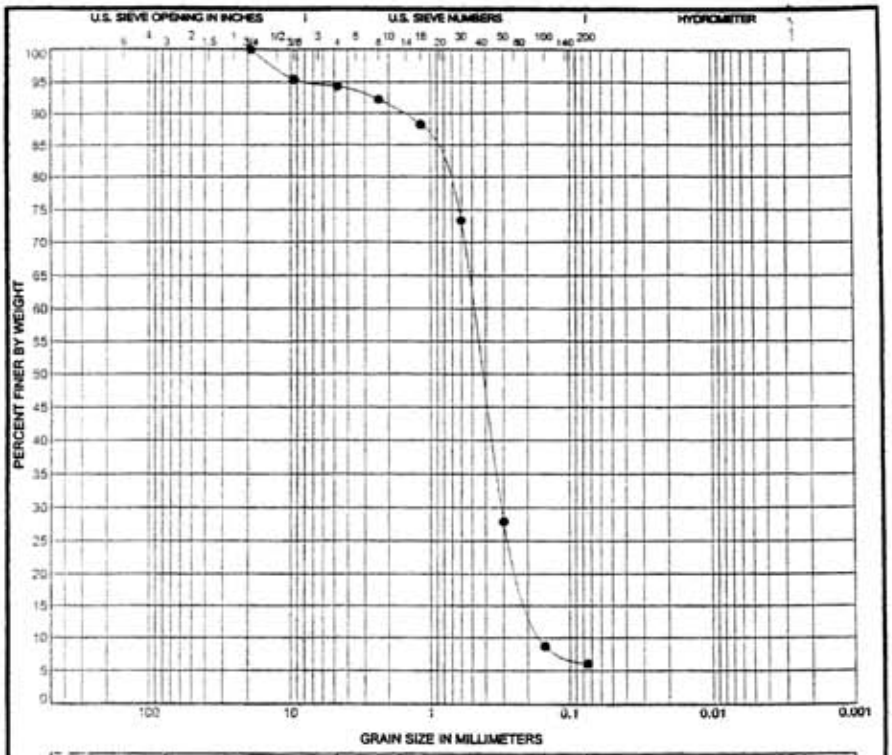
Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 6	29ft	POORLY GRADED SAND WITH SILT (SP-SM)				1.19	3.49

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 6	29ft	4.75	0.415	0.243	0.119	0	93	7	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02



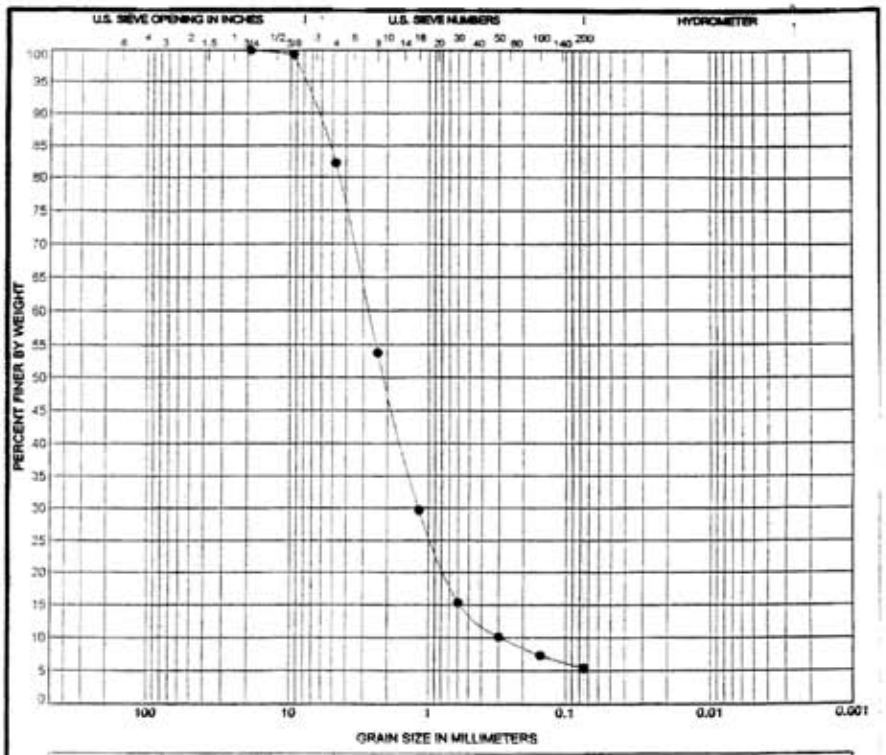
Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 6	31.5ft	POORLY GRADED SAND WITH SILT (SP-SM)				1.25	3.11

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 6	31.5ft	19	0.489	0.31	0.157	6	88	6	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-11-02



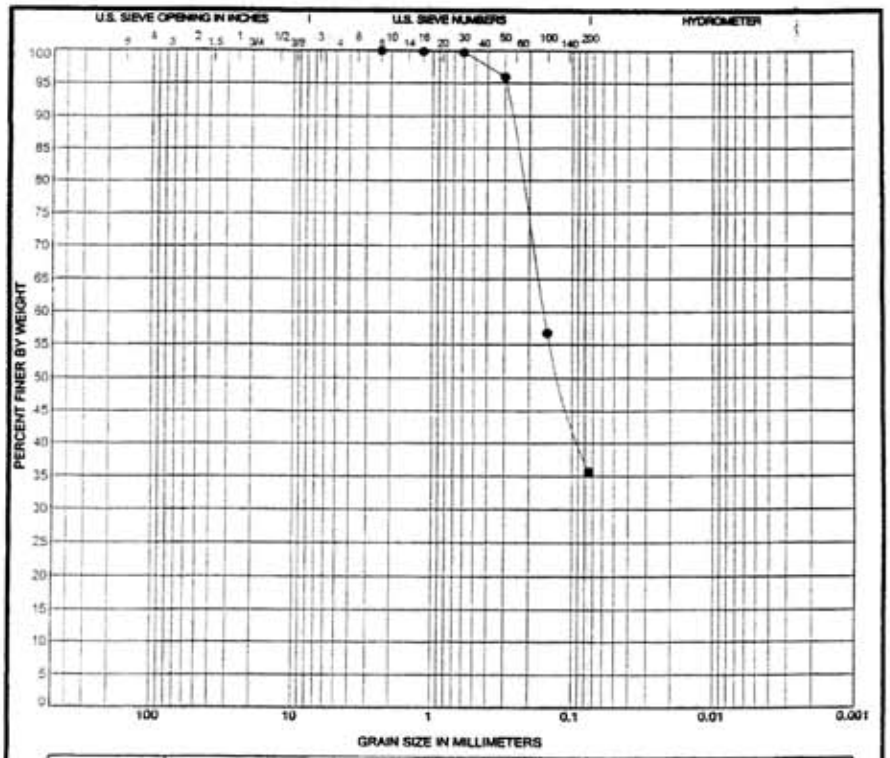
Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 6	34ft	WELL GRADED SAND WITH GRAVEL AND SILT (SW-SM)				1.80	9.58

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 6	34ft	19	2.749	1.191	0.287	18	77	5	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02



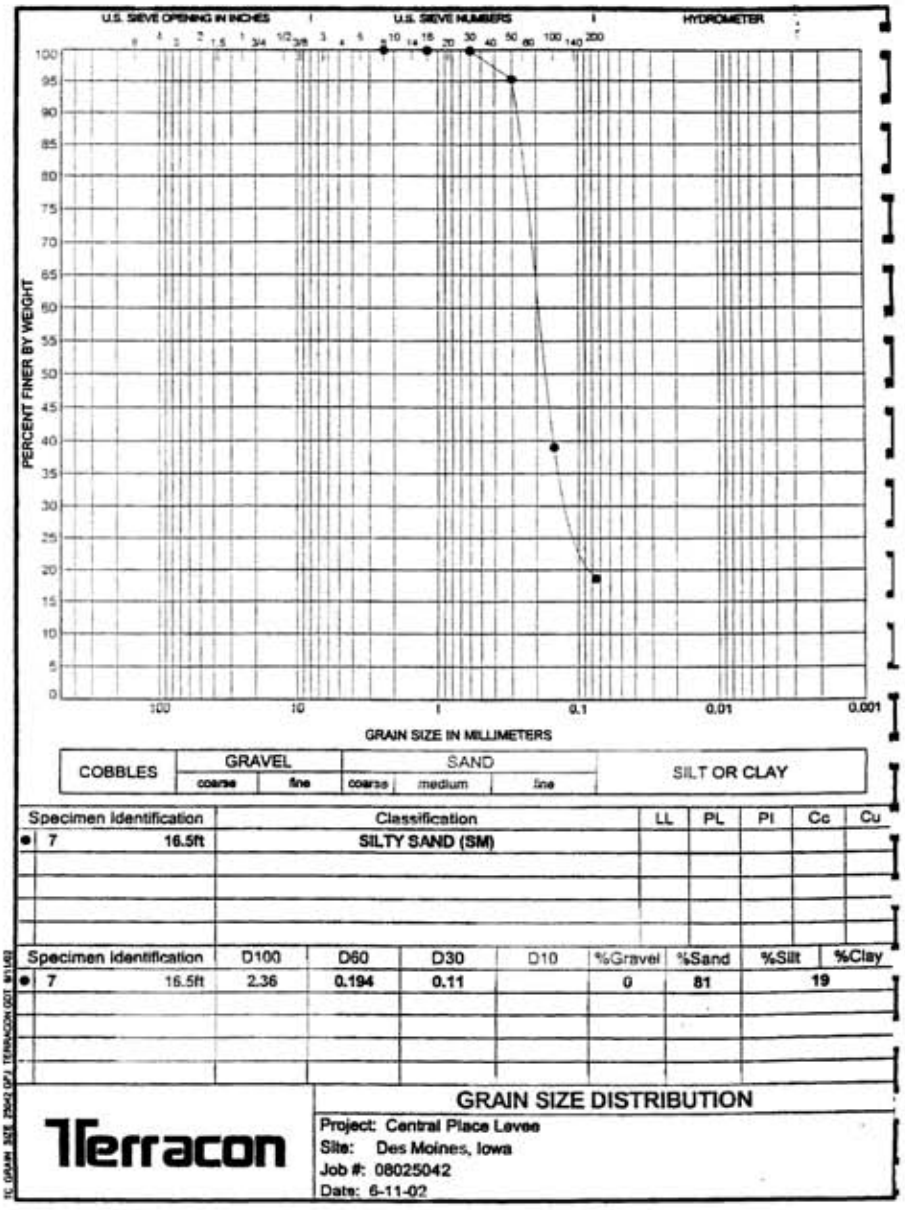
Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 7	14ft	SILTY SAND (SM)					

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 7	14ft	2.36	0.159			0	64	36	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 7	16.5ft	SILTY SAND (SM)					

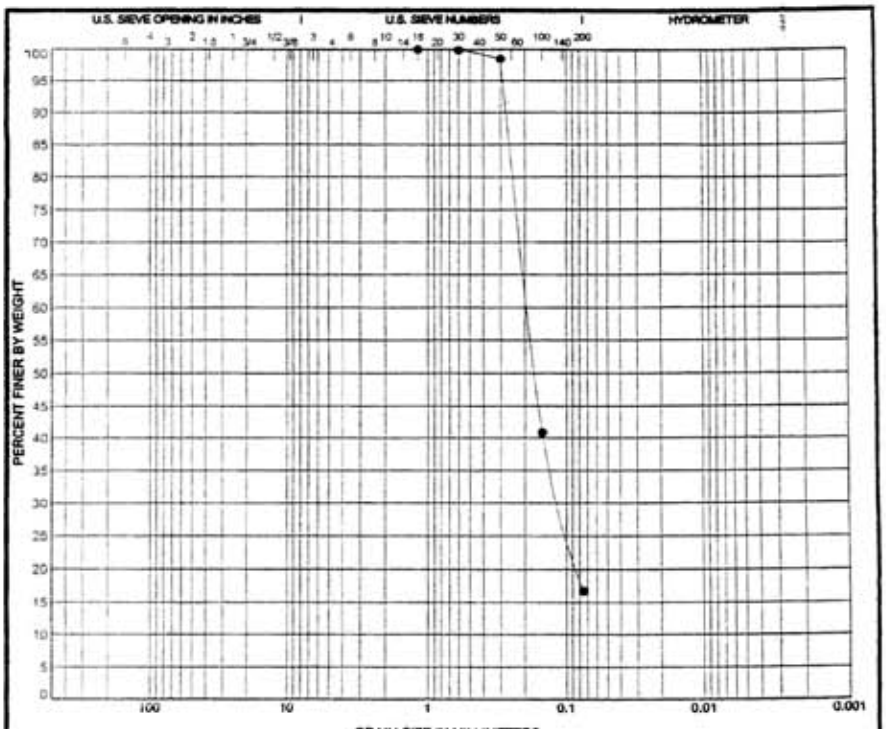
Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 7	16.5ft	2.36	0.194	0.11		0	81	19	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-11-02

TC (GRAIN_SIZE 2542.GPJ, TERRACON.GDT 8/11/02)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

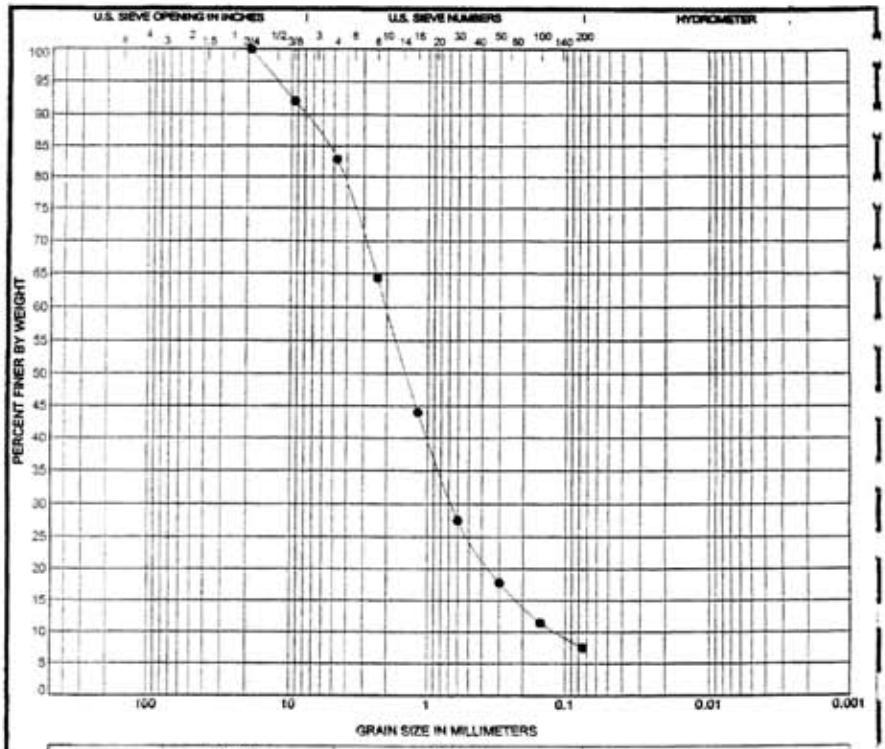
Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 7	21.5ft	SILTY SAND (SM)					

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 7	21.5ft	1.18	0.189	0.11		0	83	17	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-11-02



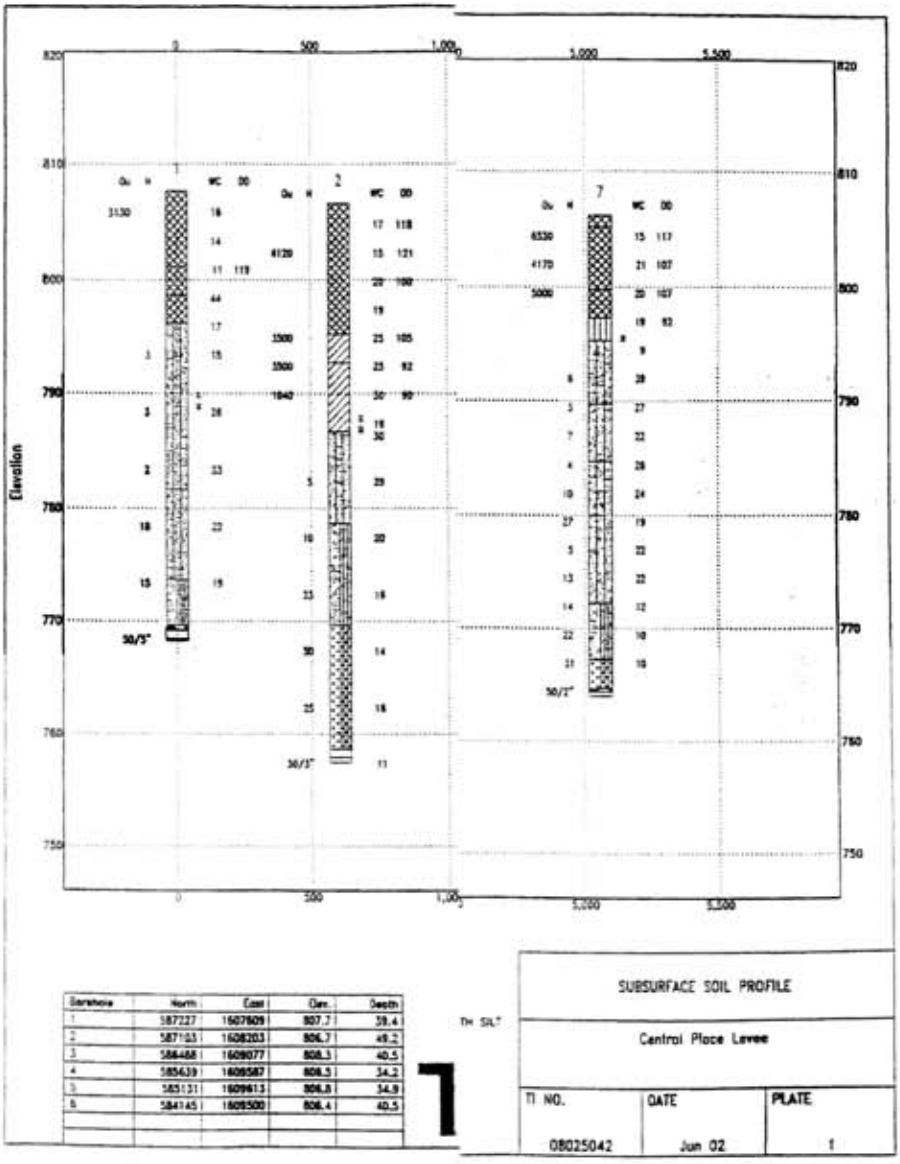
Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 7	39ft	WELL GRADED SAND WITH GRAVEL AND SILT (SW-SM)				1.88	17.68

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 7	39ft	19	2.036	0.664	0.115	17	75	8	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Central Place Levee
Site: Des Moines, Iowa
Job #: 08025042
Date: 6-3-02



Borehole	North	East	Elev.	Depth
1	587227	1607609	807.7	38.4
2	587103	1608203	806.7	48.2
3	586488	1609077	808.3	40.5
4	585639	1608587	808.5	34.2
5	585131	1609613	806.8	34.9
6	584145	1608500	806.4	40.5

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-3/8" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
ST:	Thin-Walled Tube - 2" O.D., unless otherwise noted	PA:	Power Auger
RS:	Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", N, B	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	WB:	Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value".

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling
WCI:	Wet Cave in	WD:	While Drilling
DCI:	Dry Cave in	BCR:	Before Casing Removal
AB:	After Boring	ACR:	After Casing Removal

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	<2	Very Soft
500 – 1,000	2-3	Soft
1,001 – 2,000	4-6	Medium Stiff
2,001 – 4,000	7-12	Stiff
4,001 – 8,000	13-26	Very Stiff
8,000+	26+	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Relative Density
0 – 3	Very Loose
4 – 9	Loose
10 – 29	Medium Dense
30 – 49	Dense
50+	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75 mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifiers	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1-10
Medium	11-30
High	30+

Terracon

Form 108-9-00

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3^E$	GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3^E$	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel[F, G, H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3^E$	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3^E$	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G, H, I]
			Fines classify as CL or CH	SC	Clayey sand[G, H, I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K, L, M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K, L, M]
		organic	Liquid limit — oven dried / Liquid limit — not dried < 0.75	OL	Organic clay[K, L, M, N] / Organic silt[K, L, M, O]
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay[K, L, M]
			PI plots below "A" line	MH	Elastic silt[K, L, M]
		organic	Liquid limit — oven dried / Liquid limit — not dried < 0.75	OH	Organic clay[K, L, M, P] / Organic silt[K, L, M, Q]
Highly organic soils		Primarily organic matter, dark in color, and organic odor		PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

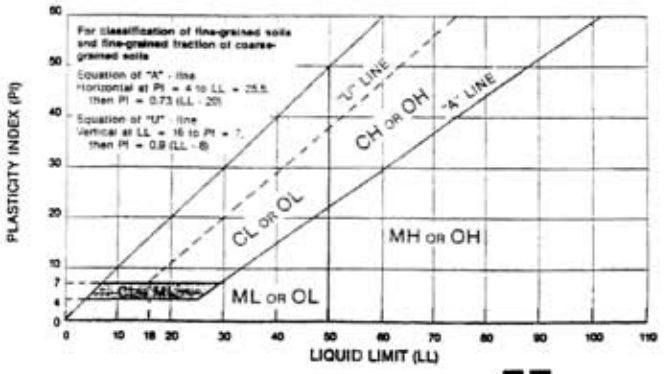
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

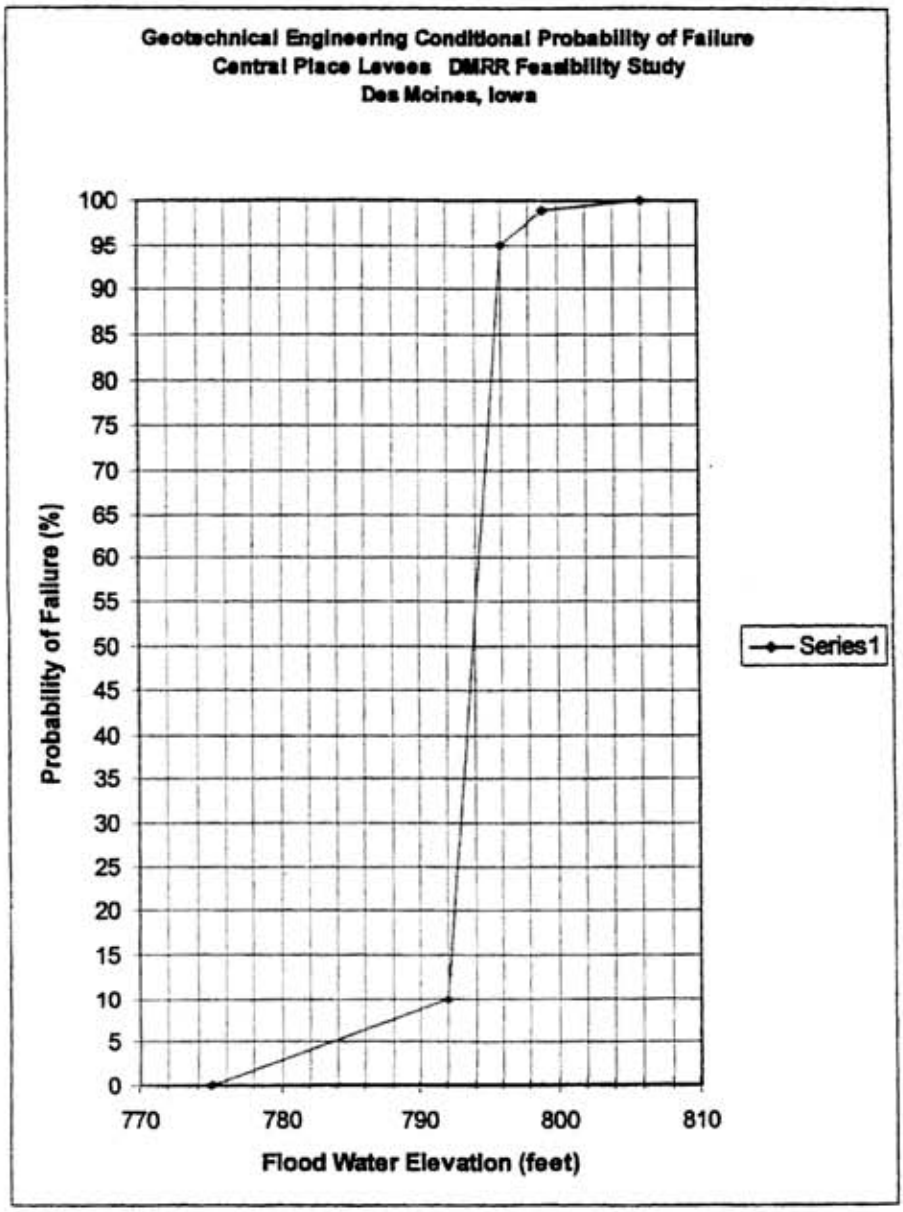
[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

Form 111—8-85


Geotechnical Engineering Conditional Probability of Failure
Central Place Levees DMRR Feasibility Study
Des Moines, Iowa
Probability of Failure (%)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
770
780
790
800
810
Flood Water Elevation (feet)
Series1

CEMVR-ED-G 28 May 2002

MEMORANDUM THRU

ED-G

FOR ED-DM (Roger Less)

Subject: Geotechnical Engineering Conditional Probability of Failure for Existing Levees at Central Place Levees (Des Moines, Iowa Feasibility Study)

1. References:

a. E-Mail Message, CEMVR-ED-DM, 15 May 2002, Subject: Central Place Levee Failure Analysis.

b. E-Mail Message, CEMVR-ED-DM, 22 April 2002, Subject: Levee System Performance, 1993 Flood.

c. E-Mail Message, CEMVR-ED-DM, 1 April 2002, Subject: City of Des Moines non-Federal Levee Performance during Flood of 1993.

d. E-Mail Message, CEMVR-ED-DM, 29 March 2002, Subject: Central Place Existing Levee Condition.

e. E-Mail Message, Mr. Jim Morano, City of Des Moines, 27 March 2002, Subject: Levee System Performance, 1993 Flood.

f. Mail Message, CEMVR-ED-DM, 06 March 2002, Subject: Historical Flood Data.

g. Memorandum, CEMVR-ED-HH, 19 December 2001, Subject: Estimated Level of Protection of Existing Levee Prior to ED-G Risk-Based Analysis.

h. Memorandum, CEMVR-ED-G, 11 December 2001, Subject: Risk-Based Analysis in Geotechnical Engineering for Central Place Levees (Des Moines Metro Study).

i. Memorandum, CEMVR-ED-DM, 21 November 2001, Subject: Central Place Levee Deficiencies That a New Design/Project Would Correct" and "Existing Deficiencies to be Repaired.

j. E-Mail Message, CEMVR-ED-HH, 08 November 2001, Subject: Request for Geotechnical Failure Analysis at Central Place.

Attachment 2

k. E-Mail Message, CEMVR-ED-DM, 06 September 2001, Subject: Birdland Park and Central Place.

l. Paper, Federal Emergency Management Agency (FEMA), 1 October 2000, Subject: Guidance on Levee Certification for the National Flood Insurance Program.

m. Memorandum, CECW-EG, 1 July 1999, Subject: Guidance for the Use of Expert Elicitation in Geological and Geotechnical Engineering Applications.

n. ETL 1110-2-556, CECW-EG, 28 May 1999, Subject: Engineering and Design, Risk-Based Analysis in Geotechnical Engineering for Support of Planning Studies.

o. Paper, Department of Civil and Environmental Engineering, Virginia Tech, Blacksburg, VA, 14 May 1999, Subject: Factors of Safety and Reliability in Geotechnical Engineering.

p. Memorandum, CECW-E, 22 August 1997, Subject: The Use of Expert Elicitation in Engineering Assessments.

2. A recent in-depth search was conducted to determine current Corps of Engineer geotechnical engineering risk-based analysis guidance to use in the evaluation for the existing levee embankment at Central Place in Des Moines, Iowa (reference "h"). References stated herein, addressing a variety of guidance, were thoroughly examined by CEMVR-ED-G for their content in providing this guidance as to determination of conditional probability of failure for the subject project. The references pertain to both current and previous methods of establishing probability of failure. In addition, onsite observations of levee conditions and distress during periods of high river conditions, are also referenced herein. These observations were noted by City of Des Moines and Corps personnel.

3. The first set of guidance examined (reference "n") revealed that the end result expressed was that engineering systems such as embankments are complex and have many performance modes. It goes on to reveal that rational estimation of the overall reliability of an embankment is a topic that is beyond the scope of this report. It was further stated that this document needs further research and refinement of these analyses in addition to the fact that much work remains to be done in developing methodology for determination techniques. More importantly, engineering judgment regarding the probability of failure for modes other than those analyzed, need to be incorporated into the analysis in a quantified manner. Following these conclusions, recommendations were made to continue development and implementation of a probabilistic approach to assessment of existing levees that included development and revision of software, additional research on wider range of levee conditions, alternative approaches, length

effects, etc., additional initial research on probabilistic frequency and categorization of levee performance, and training of geotechnical engineers expected to use the developed methodology.

4. The second set of guidance examined (reference "o") revealed that the purpose of the paper was to show that reliability concepts can be applied in simple ways, without more data, time or effort than are commonly available to make useful evaluations of reliability. It was advocated to use the probability of failure as a supplement to the factor of safety analyses.

5. The third set of guidance examined (reference "l") revealed that the use of risk-basked analysis by the Corps of Engineers in flood damage reduction project formulation studies has created a disconnect between the Corps analysis and FEMA levee certification policy. FEMA's policy requires that levee be structurally sound, properly maintained, and have at least three feet of freeboard above the 100-year flood profile elevations. The Corps risk-basked analysis eliminates the concept of arbitrary freeboard by incorporating risk and uncertainty throughout the formulation process. FEMA suggests guidance to be considered as three possibilities. First, existing levees with no risk-based analysis available, second, existing and proposed levees with risk-basked analysis available, and third, engineering evaluation. The first consideration should be evaluated by the Corps based primarily on FEMA criteria with exceptions to this being geotechnical uncertainties and current levee conditions. The second consideration involves project performance and certification contingent upon a structural and geotechnical evaluation for existing levees, whereby proposed levees issues are assumed to be accounted for. The third consideration entails determination of water elevation at which the levee is not likely to fail based on available existing information. Data derived from field inspections of the levee and structures are to be used to evaluate the adequacy of maintenance. In addition, an engineering analysis shall be accomplished to examine the embankment stability, underseepage, through seepage, and erosion protection. From this, a no risk-based analysis performance directs efforts to use the FEMA regulation for the purposes of the National Flood Insurance Program (NFIP). The regulation states that FEMA will only recognize in its flood hazard and risk mapping effort those levee systems that show evidence that adequate design and operation and maintenance systems are in place that are consistent with the level of protection sought. The design criteria requires a minimum freeboard of three feet above the water-surface level of the base flood with exceptions based on engineering analysis, that no appreciable erosion of the levee embankment can be expected during the base flood as a result of either currents or waves, that the levee embankment is sound based on engineering stability analyses, that future losses of freeboard will not occur as a result of levee settlement, in addition to interior drainage and other design criteria issues. The operation criteria requires that all closure devices or mechanical systems for internal drainage must be in operation with an official adopted operation manual. The maintenance criteria requires that the levee systems must be maintained with an official adopted maintenance plan

to include the maintenance activities to be performed, the frequency of their performance, and the person responsible for their performance. Certification requirements require that data submitted to support given levee systems comply with the structural requirements in this regulation and be certified by a registered professional engineer along with a certified as-built set of plans.

6. Historical information about the existing levees is presented herein by two key sources of personnel. These sources are the City of Des Moines and the US Army Corps of Engineers Engineering Division (Flood Area Engineer, Project Engineer, Hydraulic Engineer, and Geotechnical Engineer). The following facts associated with the site inspection findings are as stated.

   Site inspection observations revealed that the existing levee embankment footprint and surrounding ground was heavily covered in its entirety with over-growth of trees and vegetation (reference "i"). This condition has also encouraged considerable rodent burrowing activity throughout, that endangers the levee integrity. The overgrowth beyond the crown on either side of the levee is so dense that vision is obscured for any great distance, particularly riverward, to even conduct a purposeful inspection. Much of the tree growth is due to levee slopes too steep and unstable to mow and maintain (reference "d"). Several trees were excessive in diameter and height. The root systems have undoubtedly penetrated the levee section sufficiently to cause the development of seepage paths. It is well known that root systems will rot upon the death of a tree and leave potential seepage pathways in the levee embankment.

   From current (2002) and previous (1962) borings, the indicated composition of soils in the levee embankment and subsurface top stratum soils is generally sandy clay and silty clay type soils underlain by pervious substratum soils to bedrock shale. During recent exploratory drilling, a large soft area was found embedded in the existing levee crown. Additionally, the most alarming concern is the overwhelming evidence of miscellaneous fill in the form of concrete, bricks, rock, tree roots, asphalt, and debris that composes the embankment fill. In addition, concrete and tire debris are piled against the existing levee embankment. Verification of this was recently discovered during current May 2002 onsite exploratory drill borings that revealed a 4-foot thickness of concrete rubble was located within and at the center of the existing levee embankment. The bottom of this concrete rubble was determined to have been placed at natural ground level. Much of this variety is due to construction conducted at different times by different methods.

   The City of Des Moines personnel stated that prior to overtopping of the levee by some 6 inches on July 11, 1993, observed boils indicated a seepage problem was occurring beneath the levee (reference "j"). It was also stated that the boils were under control at this time. Since then, the City has raised the levee crest up another 2 feet above the 1993 flood profile (reference "b"). The City also has stated that severe distress in the form of a potential breach had developed around

the levee at Indiana Avenue in 1993, prior to the levee being overtopped (reference "e"). Distress here and elsewhere mentioned that there was excessive sponginess at the landside toe in some areas, soft spots on the landside levee slope, poor embankment conditions around some pump station discharge pipes, and scour attacking some areas on the riverside levee slope.

It was stated that historically, the existing levee has demonstrated the ability to withstand flood stage elevation from about 801 to 802 NGVD (27 to 28 City of Des Moines Datum) with an assumed 5 percent probability of failure (reference "g").

City of Des Moines personnel placed a substantial amount of earthen fill material in the early 1950's to provide flood protection to Central Place reaches of the river (reference "k").

This floodplain protected-area has been mapped by FEMA as having 100-year protection. However, the levee does not meet the minimum Public Law 84-99 levee eligibility standards for urban levees by the US Army Corps of Engineers.

The borrow material for these levees, considered by the City of Des Moines to be acceptable levee construction material, was reported to have come from the construction excavation for the Veteran's Auditorium. However, the levee material placement was generally random with no reported compaction requirements. Additionally, subsurface exploration and seepage cutoff trenches were not provided in the original construction of these non-Federal levees.

Due to the presence of aging utilities, pipes, and pump stations, an ongoing concern for their integrity is present. Also, in the subsequent years since the 1950's, the levees at Central Place were allowed to become heavily overgrown with trees. It is thought that low level spoil bank levees may lie beneath the existing levee. These levees consisted of tree overgrowth that was cut-off and removed with stumps filled over (reference "c"). Locals have stated that no attempts were made to grub underlying lands or embankments or re-compact existing spoil piles. On the riverside, levee material has been placed around existing large mature trees that were allowed to remain in place.

The Central Place levees showed signs of distress and back-flooding through interior drainage pump stations prior to being overtopped in 1993 (reference "a"). It should be noted that the catastrophic flood level of 1993 was 6 feet higher than any previous flood-of-record on the Raccoon River and 3 to 4 feet higher than previous 1954 record flood levels on the Des Moines River (reference "f").

It is anticipated that during future floods, when the levees must perform with water in the freeboard range, that the levee system will have the same performance problems in addition to the on-going stream bank and levee erosion problems. This condition can be critical since regulation changes in outflow from

Saylorville Dam, located 10 miles upstream from downtown Des Moines, affect this levee system in about 3 hours.

Furthermore, as the heavy tree growth continues to mature, dead and overturned trees will become more of a threat to the levee embankment integrity.

Because of the crude methods of constructing the existing levee embankment, it will not be unexpected to find tree stumps, construction rubble, pervious soil material, and poor compaction throughout the existing embankment. Also, it will not be surprising to find landfill dumping, old appliances, construction rubble/debris, and common household type garbage upon excavation of the proposed inspection trench.

7. Following extensive review of this documented information and available methods of analyzing existing levee systems, an in-depth meeting was conducted on May 15th, 2002 between personnel from CEMVR-ED-G and CEMVR-ED-DM to examine the options. Following extensive discussion, it was agreed by both parties that it best serves this project's existing levee embankment conditions to select risk-based analysis guidance in the form of expert elicitation. This guidance requires a geotechnical engineering assessment of the probability of unsatisfactory performance (references "m" and "p").

8. In summary, based upon visual observations, findings, and performance both during and following the historical flood of 1993, a failure analysis table was created and presented herein (attachment 1) stating the percent probability of failure to flood water elevation in both NGVD elevation and City of Des Moines datum. A chart (attachment 2) depicting this table is also presented herein. The flood water elevation of 796 NGVD (22 City of Des Moines Datum) is hereby selected as the determining flood water elevation. This elevation is indicated to be the natural ground level at the landside toe of the levee, based upon last years (2001) levee embankment cross-sections, surveyed by City of Des Moines personnel. In conclusion, when flood water falls below this elevation, a significant reduction in probability of failure occurs. When flood water rises above this elevation, a rapid increase to failure certainty occurs.

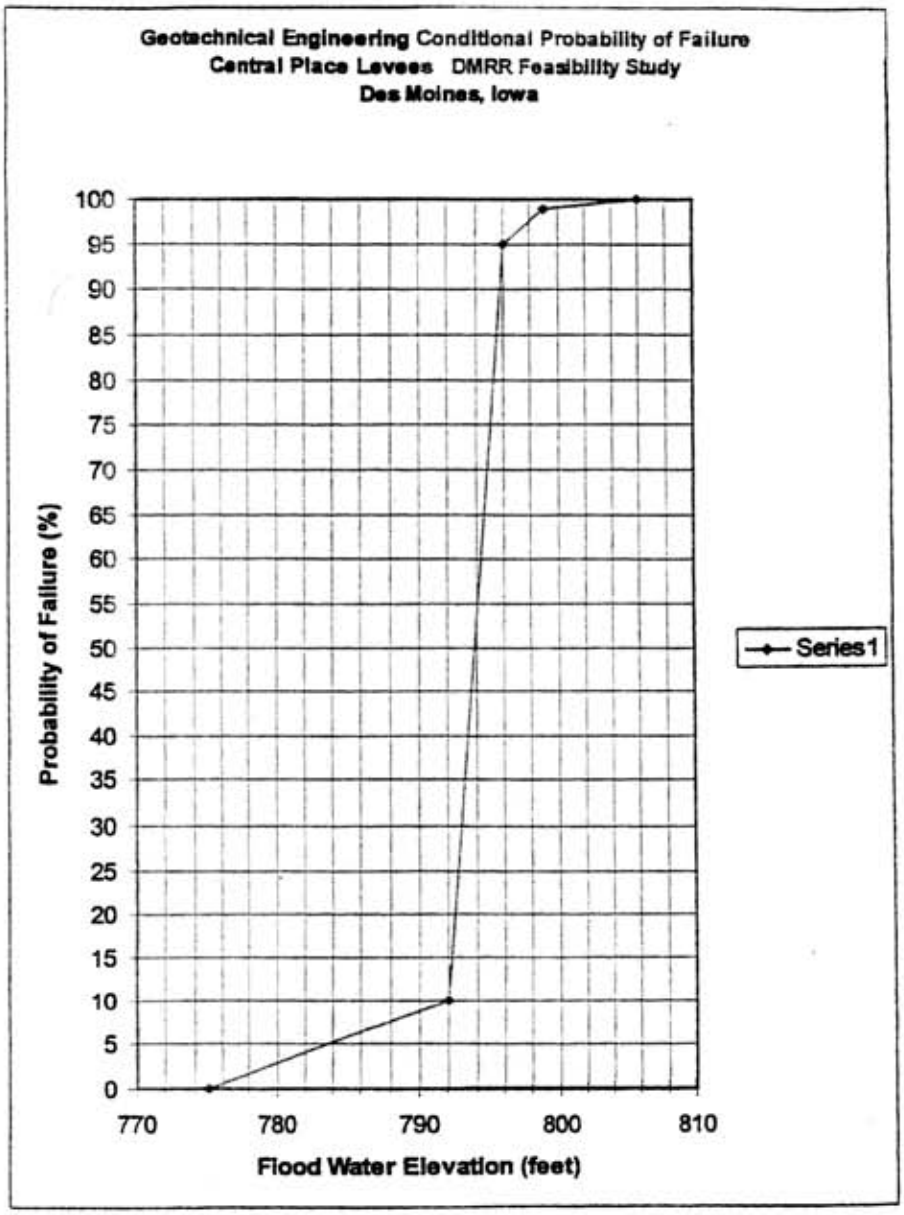
DONALD H. BAWMANN
Geotechnical Branch

See Attachments
1. Failure Analysis Table
2. Conditional Probability of Failure Chart

CF:
ED-G (FILES)
ED-DM (Cerny)

FAILURE ANALYSIS TABLE

Flood Water Elevation in City of Des Moines Datum (NGVD) (feet)	Percent Probability of Failure	Description of Elevation
1 (775)	0	Invert of storm sewer system near levee
18 (792)	10	Riverside ground level
22 (796)	95	Landside ground level at landside toe of levee
25 (799)	99	Average base elevation of existing levee
32 (806)	100	Selected average top elevation of existing levee


Geotechnical Engineering Conditional Probability of Failure
Central Place Levees DMRR Feasibility Study
Des Moines, Iowa
Probability of Failure (%)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
770
780
790
800
810
Flood Water Elevation (feet)
Series1

FEASIBILITY REPORT
FLOOD DAMAGE REDUCTION
FOR
DES MOINES AND RACCOON RIVERS PROJECT
DES MOINES, IOWA

WITH INTEGRATED
ENVIRONMENTAL ASSESSMENT

VOLUME 3

FIGURES, EXHIBITS, AND PLATES

December 2005

US Army Corps of Engineers
Rock Island District

Volume 3

FLOOD DAMAGE REDUCTION DES MOINES AND RACCOON RIVERS PROJECT

FEASIBILITY REPORT

DES MOINES, IOWA WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

11"X 17" FIGURES, EXHIBITS, AND PLATES

Prepared by
U.S. Army Corps of Engineers
Rock Island District
July 28 2004

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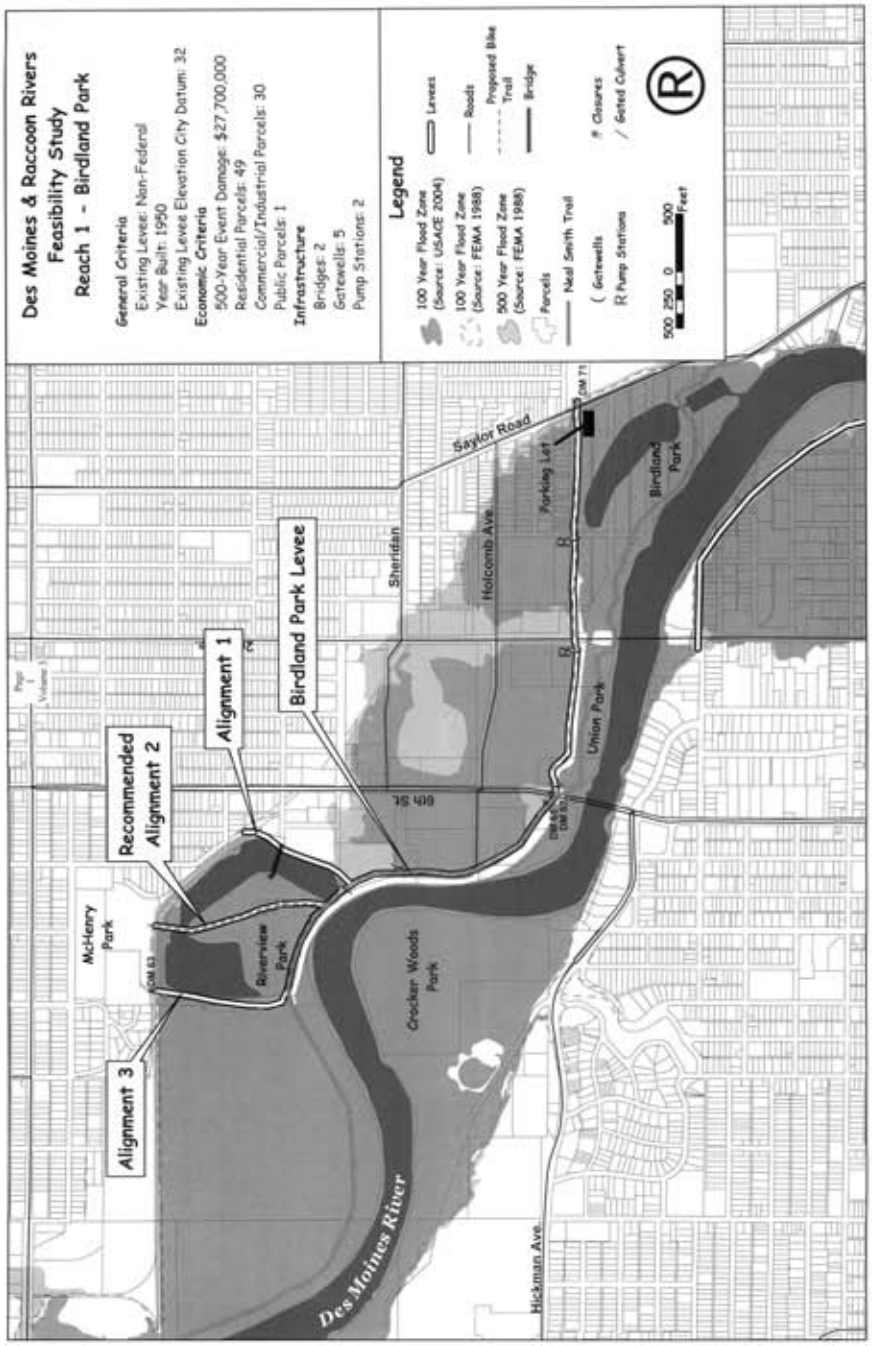

Des Moines & Raccoon Rivers
Feasibility Study
Reach 1 - Birdland Park
General Criteria
Existing Levee: Non-Federal
Year Built: 1950
Existing Levee Elevation City Datum: 32
Economic Criteria
500-Year Event Damage: $27,700,000
Residential Parcels: 49
Commercial/Industrial Parcels: 30
Public Parcels: 1
Infrastructure
Bridges: 2
Gatewells: 5
Pump Stations: 2
Legend
100 Year Flood Zone (Source: USACE 2004)
100 Year Flood Zone (Source: FEMA 1988)
500 Year Flood Zone (Source: FEMA 1988)
Parcels
Neal Smith Trail
Gatewells
Pump Stations
Levees
Roads
Proposed Bike Trail
Bridge
Closures
Gated Culvert
500 250 0 500 Feet
Recommended Alignment 2
Alignment 1
Alignment 3
Birdland Park Levee
Sheridan
Holcomb Ave.
Saylor Road
Parking Lot
Birdland Park
Union Park
Crocker Woods Park
McHenry Park
Riverview Park
Hickman Ave.
Des Moines River
69th St.

PLATE 1

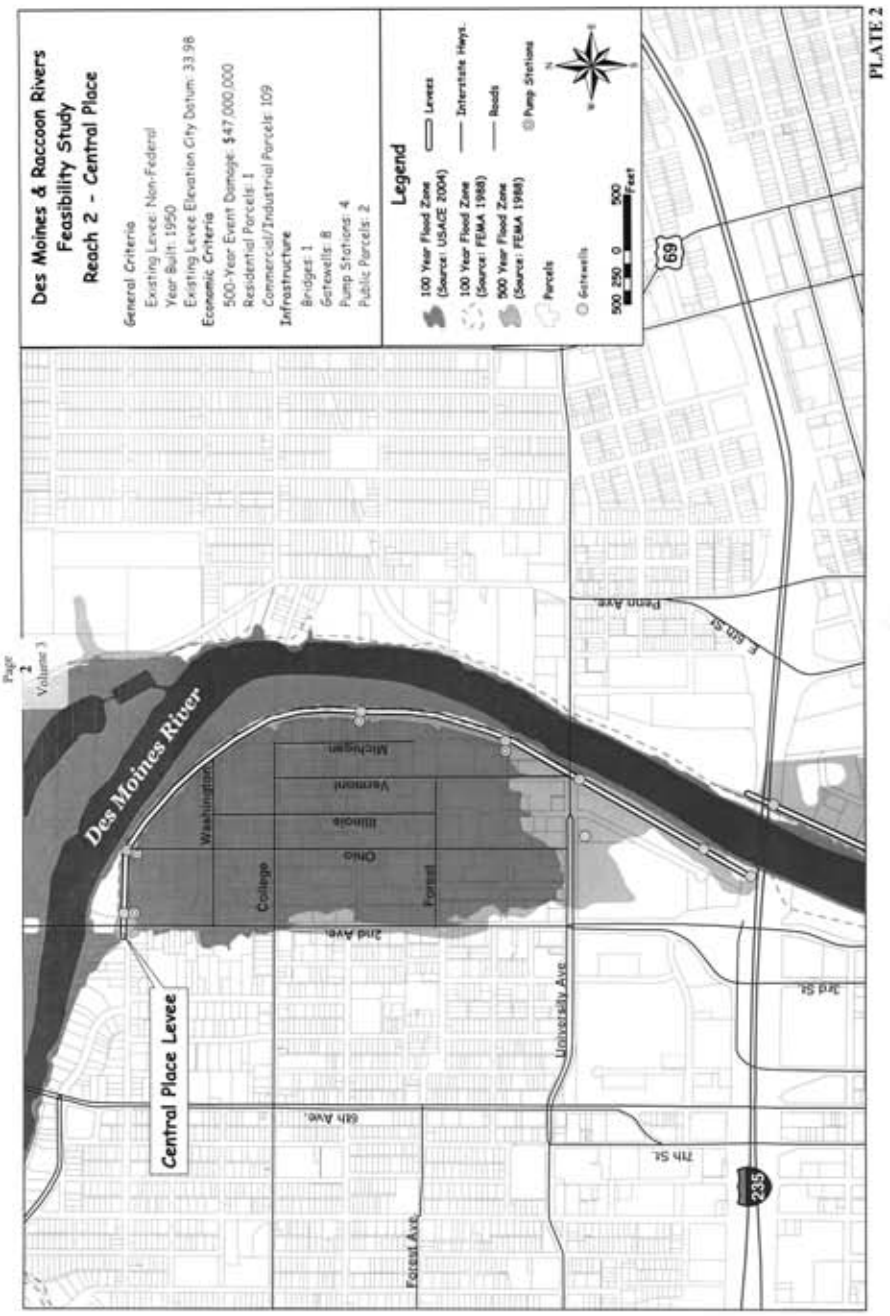

Des Moines & Raccoon Rivers
Feasibility Study
Reach 2 - Central Place
General Criteria
Existing Levee: Non-Federal
Year Built: 1950
Existing Levee Elevation City Datum: 33.98
Economic Criteria
500-Year Event Damage: $47,000,000
Residential Parcels: 1
Commercial/Industrial Parcels: 109
Infrastructure
Bridges: 1
Gatewells: 8
Pump Stations: 4
Public Parcels: 2
Legend
100 Year Flood Zone (Source: USACE 2004)
100 Year Flood Zone (Source: FEMA 1988)
500 Year Flood Zone (Source: FEMA 1988)
Parcels
Gatewells
Levees
Interstate Hwys.
Roads
Pump Stations
500 250 0 500 Feet
Des Moines River
Central Place Levee
Washington
College
Ohio
Illinois
Vernon
Michigan
Forest
2nd Ave.
6th Ave.
Forest Ave.
University Ave.
7th St.
3rd St.
E. 6th St.
Penn Ave.
235
69
Page 2
Volume 3

PLATE 2

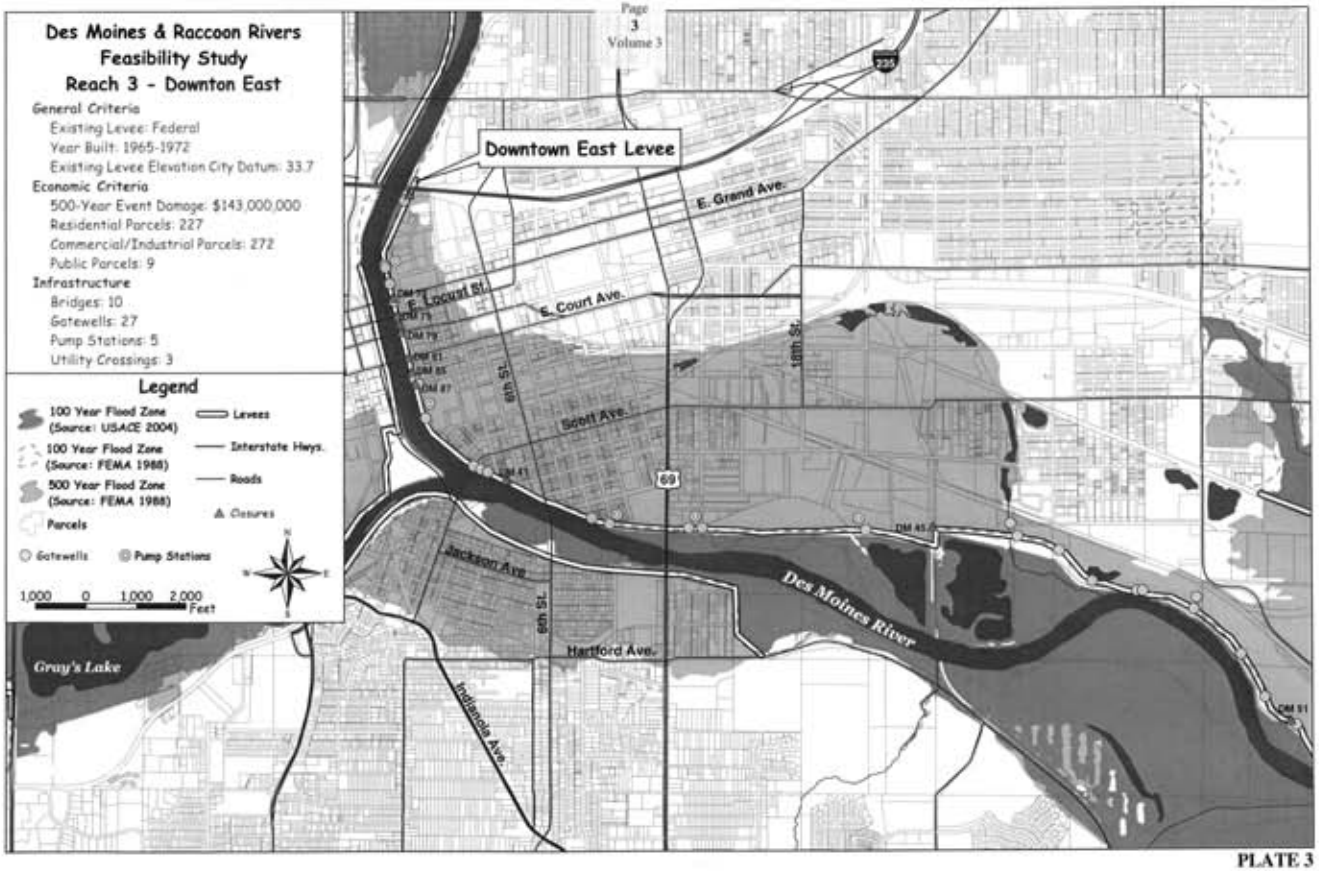
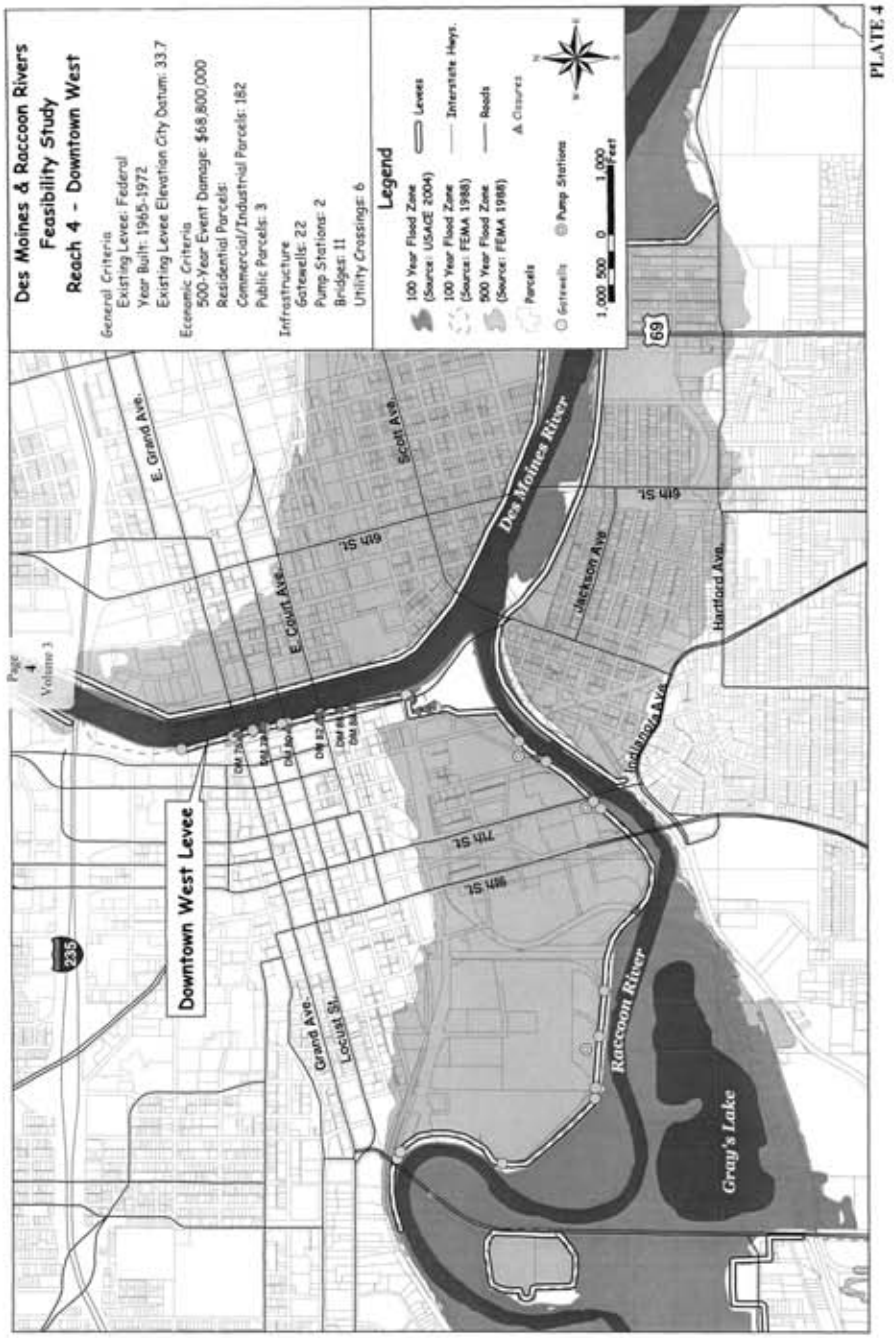
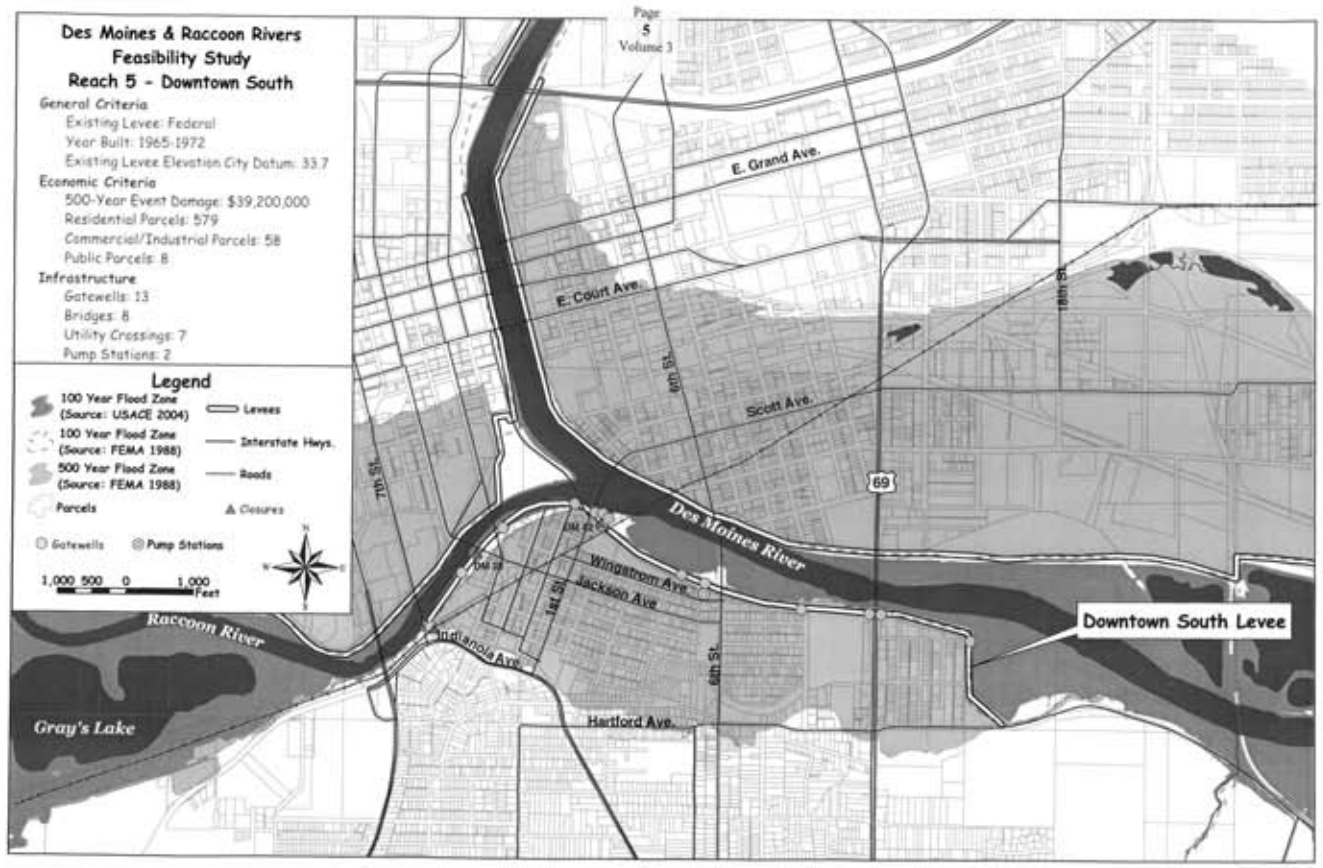

Des Moines & Raccoon Rivers
Feasibility Study
Reach 3 - Downton East
General Criteria
Existing Levee: Federal
Year Built: 1965-1972
Existing Levee Elevation City Datum: 33.7
Economic Criteria
500-Year Event Damage: $143,000,000
Residential Parcels: 227
Commercial/Industrial Parcels: 272
Public Parcels: 9
Infrastructure
Bridges: 10
Gatewells: 27
Pump Stations: 5
Utility Crossings: 3
Legend
100 Year Flood Zone (Source: USACE 2004)
100 Year Flood Zone (Source: FEMA 1988)
500 Year Flood Zone (Source: FEMA 1988)
Parcels
Gatewells
Pump Stations
Levees
Interstate Hwys.
Roads
Closures
1,000 0 1,000 2,000 Feet
Page 3 Volume 3
Downtown East Levee
E. Grand Ave.
E. Locust St.
E. Court Ave.
Scott Ave.
6th St.
18th St.
Jackson Ave.
Hartford Ave.
Indianola Ave.
Des Moines River
Gray's Lake
69
235

PLATE 3


Des Moines & Raccoon Rivers
Feasibility Study
Reach 4 - Downtown West
General Criteria
Existing Levee: Federal
Year Built: 1965-1972
Existing Levee Elevation City Datum: 33.7
Economic Criteria
500-Year Event Damage: $68,800,000
Residential Parcels:
Commercial/Industrial Parcels: 182
Public Parcels: 3
Infrastructure
Gatewells: 22
Pump Stations: 2
Bridges: 11
Utility Crossings: 6
Legend
100 Year Flood Zone (Source: USACE 2004)
100 Year Flood Zone (Source: FEMA 1988)
500 Year Flood Zone (Source: FEMA 1988)
Parcels
Levees
Interstate Hwys.
Roads
Closures
Gatewells
Pump Stations
1,000 500 0 1,000 Feet
Downtown West Levee
E. Grand Ave.
Scott Ave.
E. Court Ave.
6th St.
Des Moines River
Jackson Ave
Hartford Ave.
Indianola Ave
Grand Ave.
Locust St.
7th St.
8th St.
Raccoon River
Gray's Lake
235
69
Page 4 Volume 1
PLATE 4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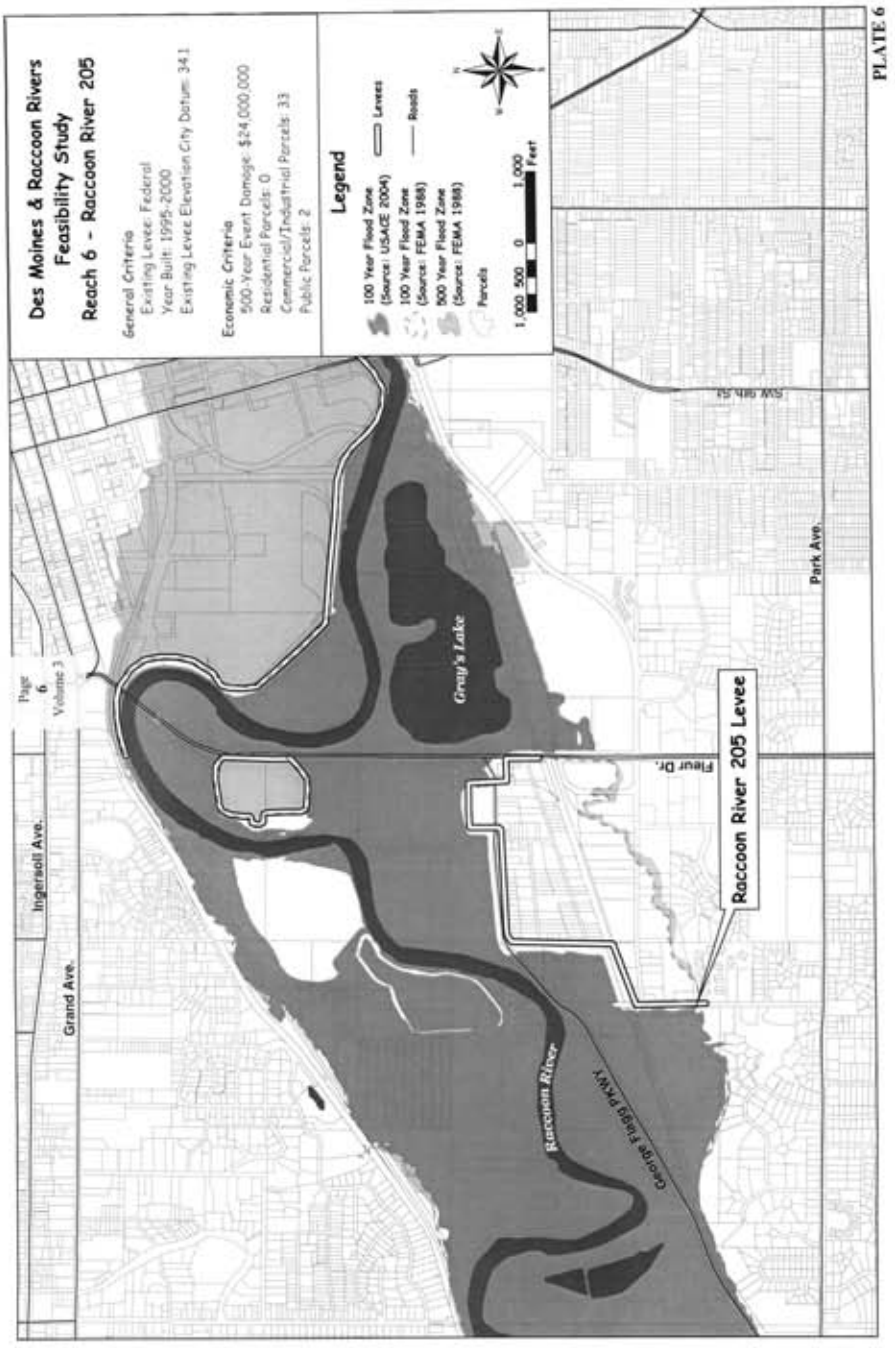
5
Volume 3
Des Moines & Raccoon Rivers
Feasibility Study
Reach 5 - Downtown South
General Criteria
Existing Levee: Federal
Year Built: 1965-1972
Existing Levee Elevation City Datum: 33.7
Economic Criteria
500-Year Event Damage: $39,200,000
Residential Parcels: 579
Commercial/Industrial Parcels: 58
Public Parcels: 8
Infrastructure
Gatewells: 13
Bridges: 8
Utility Crossings: 7
Pump Stations: 2
Legend
100 Year Flood Zone (Source: USACE 2004)
100 Year Flood Zone (Source: FEMA 1988)
500 Year Flood Zone (Source: FEMA 1988)
Parcels
Levees
Interstate Hwys.
Roads
Closures
Gatewells
Pump Stations
1,000 500 0 1,000 Feet
E. Grand Ave.
E. Court Ave.
Scott Ave.
Des Moines River
Wingstrom Ave.
Jackson Ave.
Indianola Ave.
Hartford Ave.
Raccoon River
Gray's Lake
Downtown South Levee
7th St.
6th St.
1st St.
18th St.
69

PLATE 5


Des Moines & Raccoon Rivers
Feasibility Study
Reach 6 - Raccoon River 205
General Criteria
Existing Levee: Federal
Year Built: 1995-2000
Existing Levee Elevation City Datum: 341
Economic Criteria
500-Year Event Damage: $24,000,000
Residential Parcels: 0
Commercial/Industrial Parcels: 33
Public Parcels: 2
Legend
100 Year Flood Zone (Source: USACE 2004)
100 Year Flood Zone (Source: FEMA 1988)
500 Year Flood Zone (Source: FEMA 1988)
Levees
Roads
Parcels
1,000 500 0 1,000 Feet
Page 6 Volume 3
Ingersoll Ave.
Grand Ave.
Gray's Lake
Fleur Dr.
Raccoon River 205 Levee
Raccoon River
George Flagg PKWY
SW 9th St
Park Ave.
PLATE 6

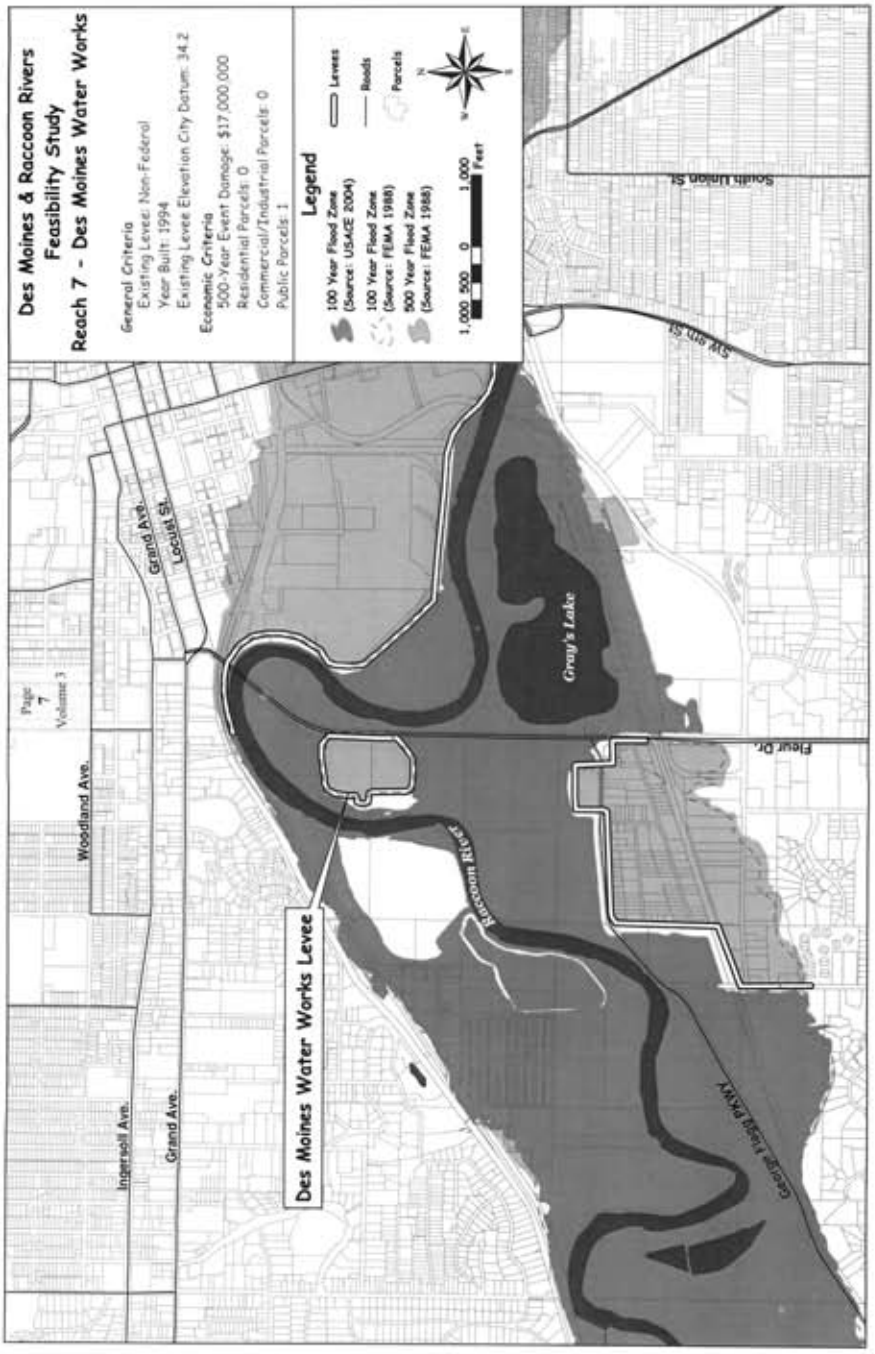

Des Moines & Raccoon Rivers
Feasibility Study
Reach 7 - Des Moines Water Works
General Criteria
Existing Levee: Non-Federal
Year Built: 1994
Existing Levee Elevation City Datum: 34.2
Economic Criteria
500-Year Event Damage: $17,000,000
Residential Parcels: 0
Commercial/Industrial Parcels: 0
Public Parcels: 1
Legend
100 Year Flood Zone (Source: USACE 2004)
100 Year Flood Zone (Source: FEMA 1988)
500 Year Flood Zone (Source: FEMA 1988)
Levees
Roads
Parcels
1,000 500 0 1,000 Feet
Des Moines Water Works Levee
Raccoon River
Gray's Lake
Fleur Dr.
George Flagg Pkwy
SW 6th St
South Union St
Woodland Ave.
Grand Ave.
Locust St.
Ingersoll Ave.
Grand Ave.
Page 7 Volume 3

PLATE 7

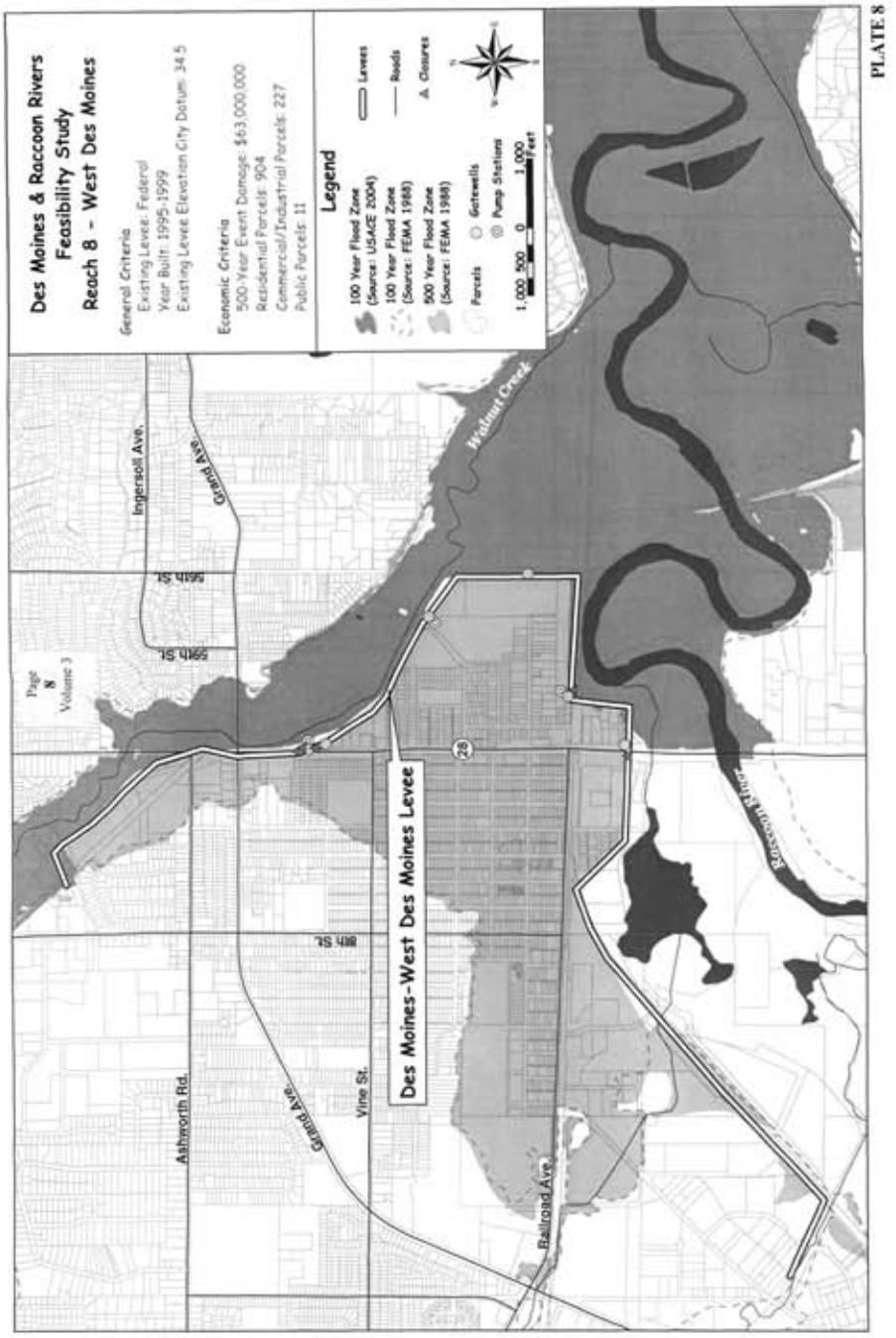

Des Moines & Raccoon Rivers
Feasibility Study
Reach 8 - West Des Moines
General Criteria
Existing Levee: Federal
Year Built: 1995-1999
Existing Levee Elevation City Datum: 34.5
Economic Criteria
500-Year Event Damage: $63,000,000
Residential Parcels: 904
Commercial/Industrial Parcels: 227
Public Parcels: 11
Legend
100 Year Flood Zone (Source: USACE 2004)
100 Year Flood Zone (Source: FEMA 1988)
500 Year Flood Zone (Source: FEMA 1988)
Parcels
Levees
Roads
Closures
Gatewells
Pump Stations
1,000 500 0 1,000 Feet
Des Moines-West Des Moines Levee
Walnut Creek
Raccoon River
Ingersoll Ave.
Grand Ave.
56th St.
59th St.
88th St.
Ashworth Rd.
Vine St.
Railroad Ave.
28
Page 8 Volume 3

PLATE 8

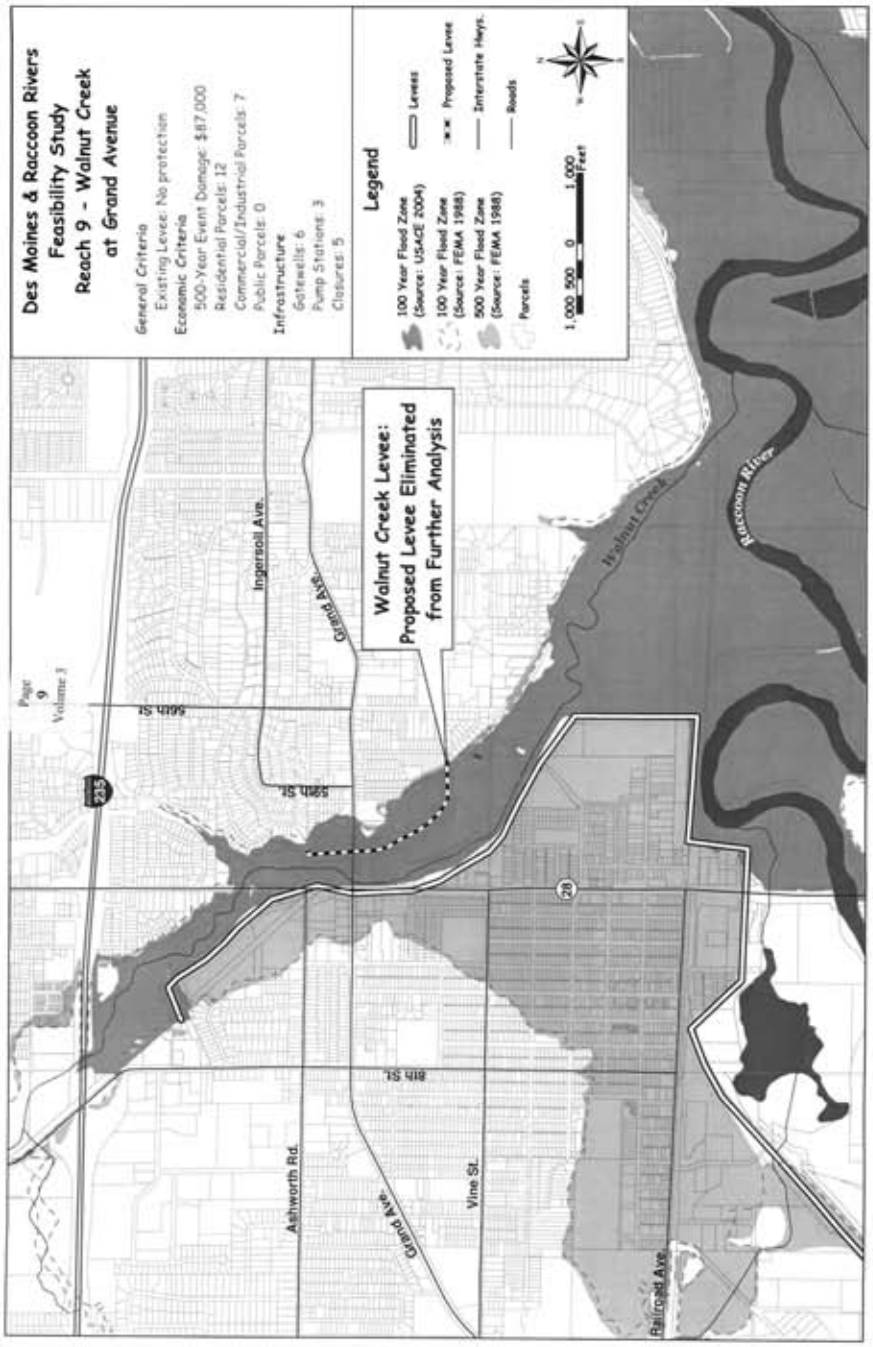
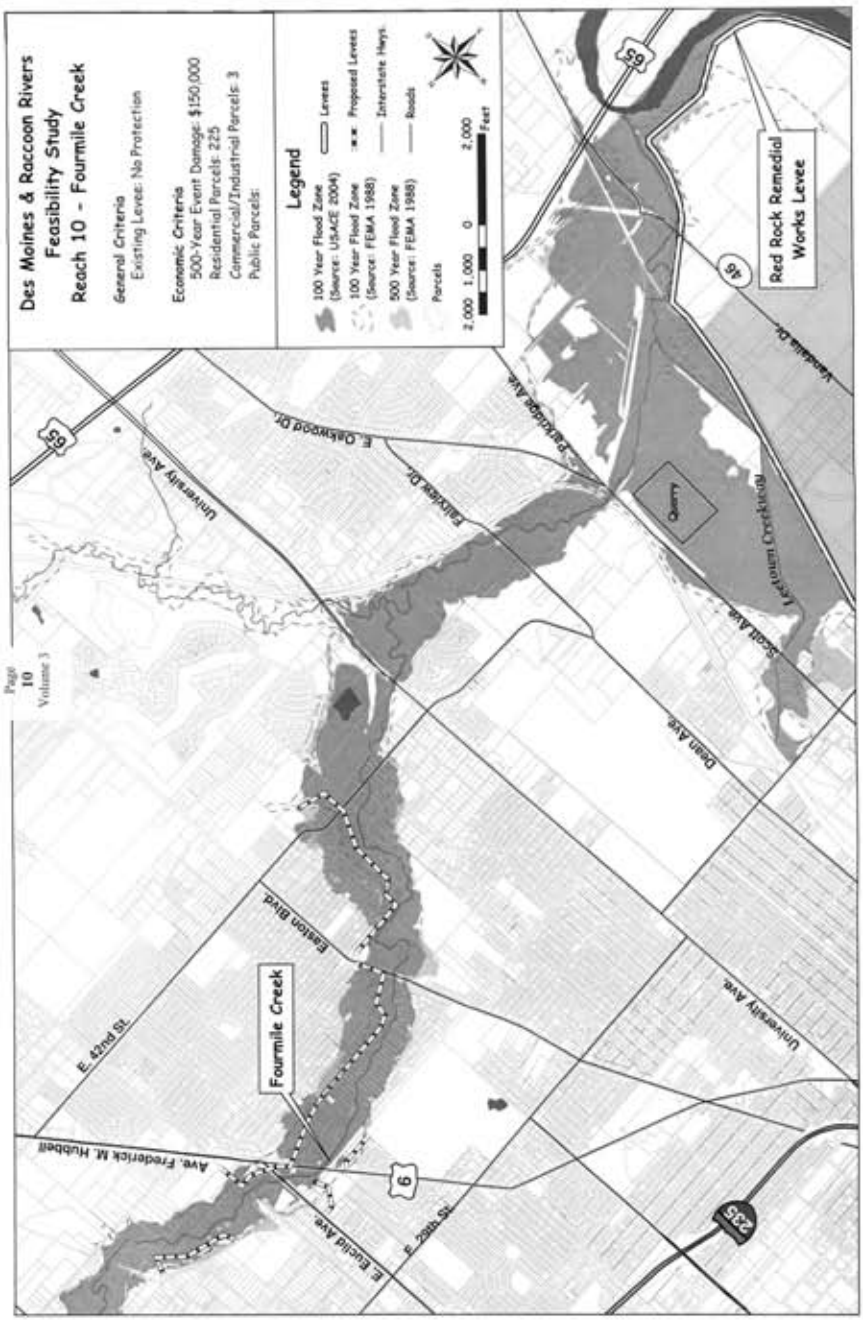

Des Moines & Raccoon Rivers
Feasibility Study
Reach 9 - Walnut Creek
at Grand Avenue
General Criteria
Existing Levee: No protection
Economic Criteria
500-Year Event Damage: $87,000
Residential Parcels: 12
Commercial/Industrial Parcels: 7
Public Parcels: 0
Infrastructure
Gatewells: 6
Pump Stations: 3
Closures: 5
Legend
100 Year Flood Zone (Source: USACE 2004)
100 Year Flood Zone (Source: FEMA 1988)
500 Year Flood Zone (Source: FEMA 1988)
Parcels
Levees
Proposed Levee
Interstate Hwys.
Roads
1,000 500 0 1,000 Feet
Walnut Creek Levee: Proposed Levee Eliminated from Further Analysis
Page 9 Volume 3
Ingersoll Ave.
Grand Ave.
Ashworth Rd.
Vine St.
Railroad Ave.
Walnut Creek
Raccoon River
235
28
56th St
59th St
8th St

PLATE 9


Des Moines & Raccoon Rivers
Feasibility Study
Reach 10 - Fourmile Creek
General Criteria
Existing Levee: No Protection
Economic Criteria
500-Year Event Damage: $150,000
Residential Parcels: 225
Commercial/Industrial Parcels: 3
Public Parcels:
Legend
100 Year Flood Zone (Source: USACE 2004)
100 Year Flood Zone (Source: FEMA 1988)
500 Year Flood Zone (Source: FEMA 1988)
Parcels
Levees
Proposed Levees
Interstate Hwys.
Roads
2,000 1,000 0 2,000 Feet
Red Rock Remedial Works Levee
Fourmile Creek
Quarry
Lectoum Creekway
E. Oakwood Dr.
Fairview Dr.
Parkridge Ave.
University Ave.
Scott Ave.
Dean Ave.
Easton Blvd.
E. 42nd St.
Ave. Frederick M. Hubbell
E. Euclid Ave.
E. 29th St.
Vandalia Dr.
Page 10 Volume 3

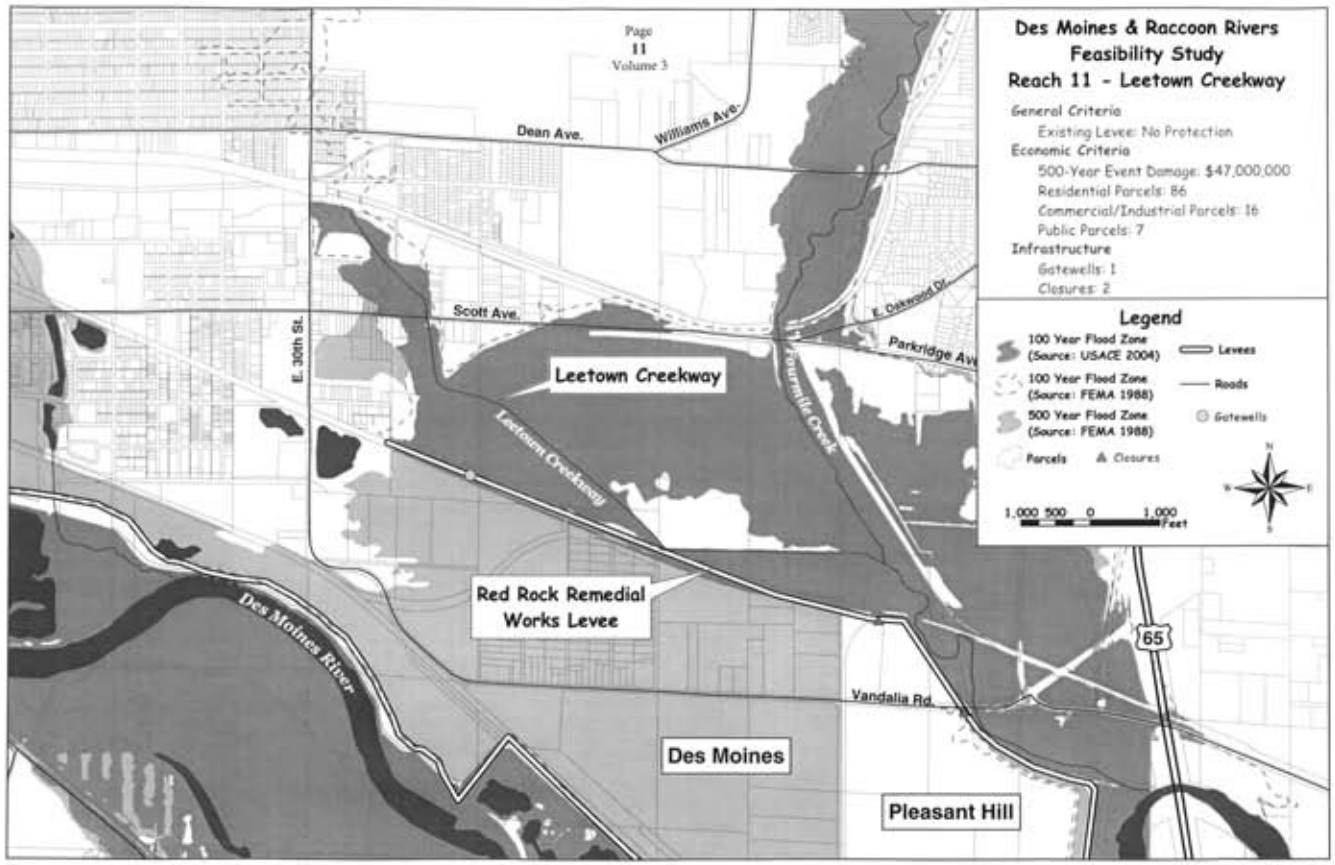

Des Moines & Raccoon Rivers
Feasibility Study
Reach 11 - Leetown Creekway
General Criteria
Existing Levee: No Protection
Economic Criteria
500-Year Event Damage: $47,000,000
Residential Parcels: 86
Commercial/Industrial Parcels: 16
Public Parcels: 7
Infrastructure
Gatewells: 1
Closures: 2
Legend
100 Year Flood Zone (Source: USACE 2004)
100 Year Flood Zone (Source: FEMA 1988)
500 Year Flood Zone (Source: FEMA 1988)
Parcels
Closures
Levees
Roads
Gatewells
1,000 500 0 1,000 Feet
Page 11 Volume 3
Dean Ave.
Williams Ave.
Scott Ave.
E. 30th St.
E. Oakwood Dr.
Parkridge Ave.
Leetown Creekway
Leetown Creekway
Fourmile Creek
Red Rock Remedial Works Levee
Des Moines River
Vandalia Rd.
65
Des Moines
Pleasant Hill

PLATE 11

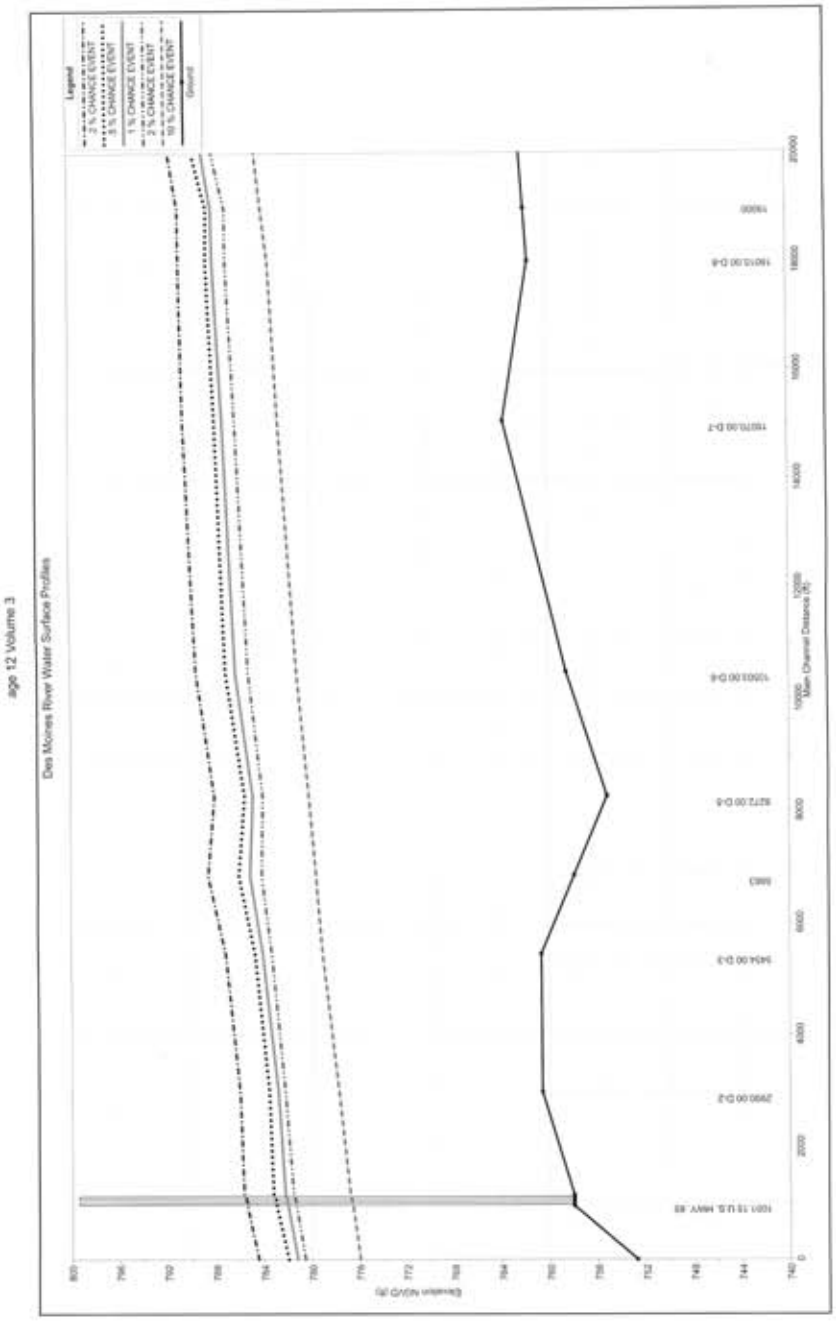


Plate A-4

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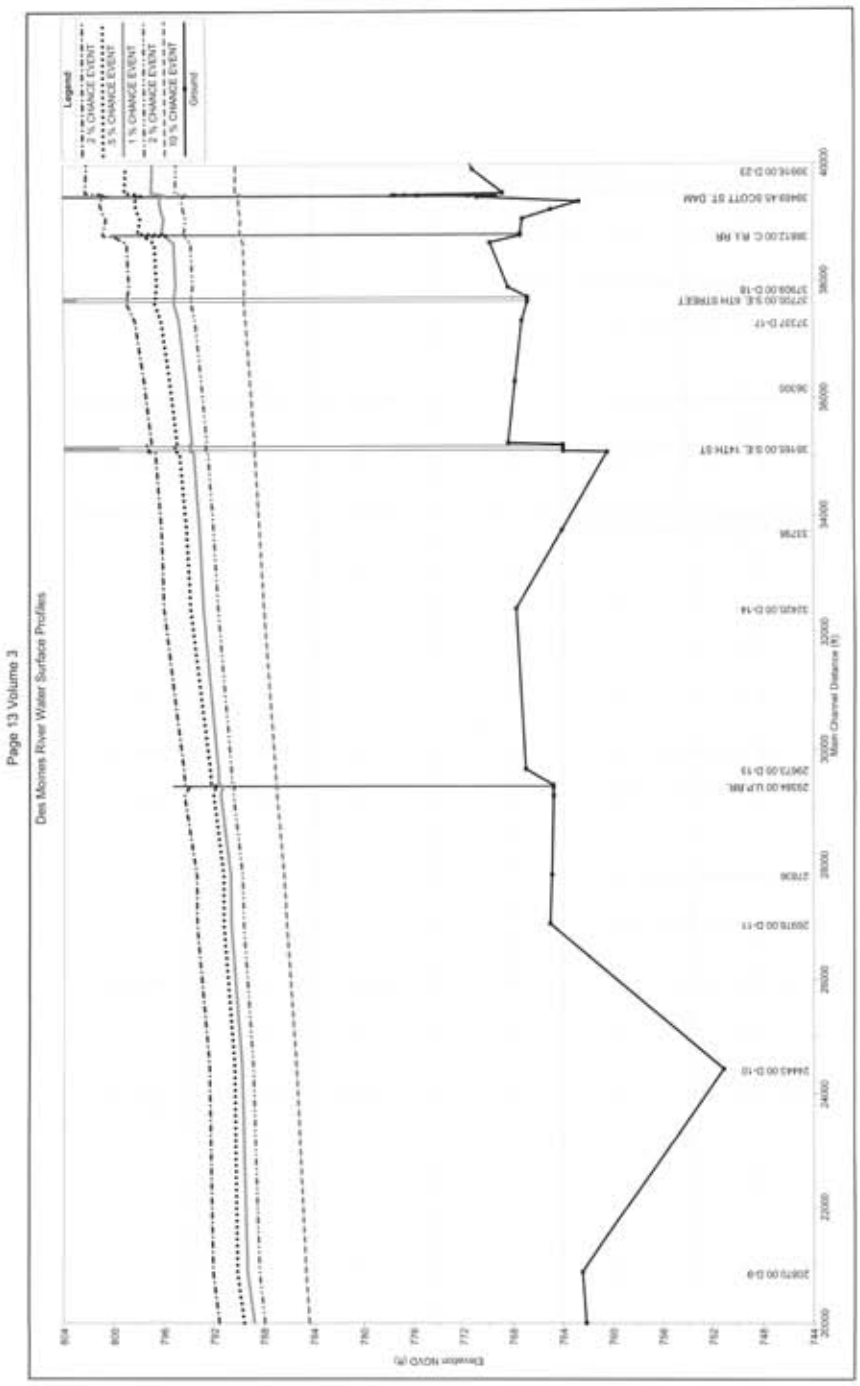
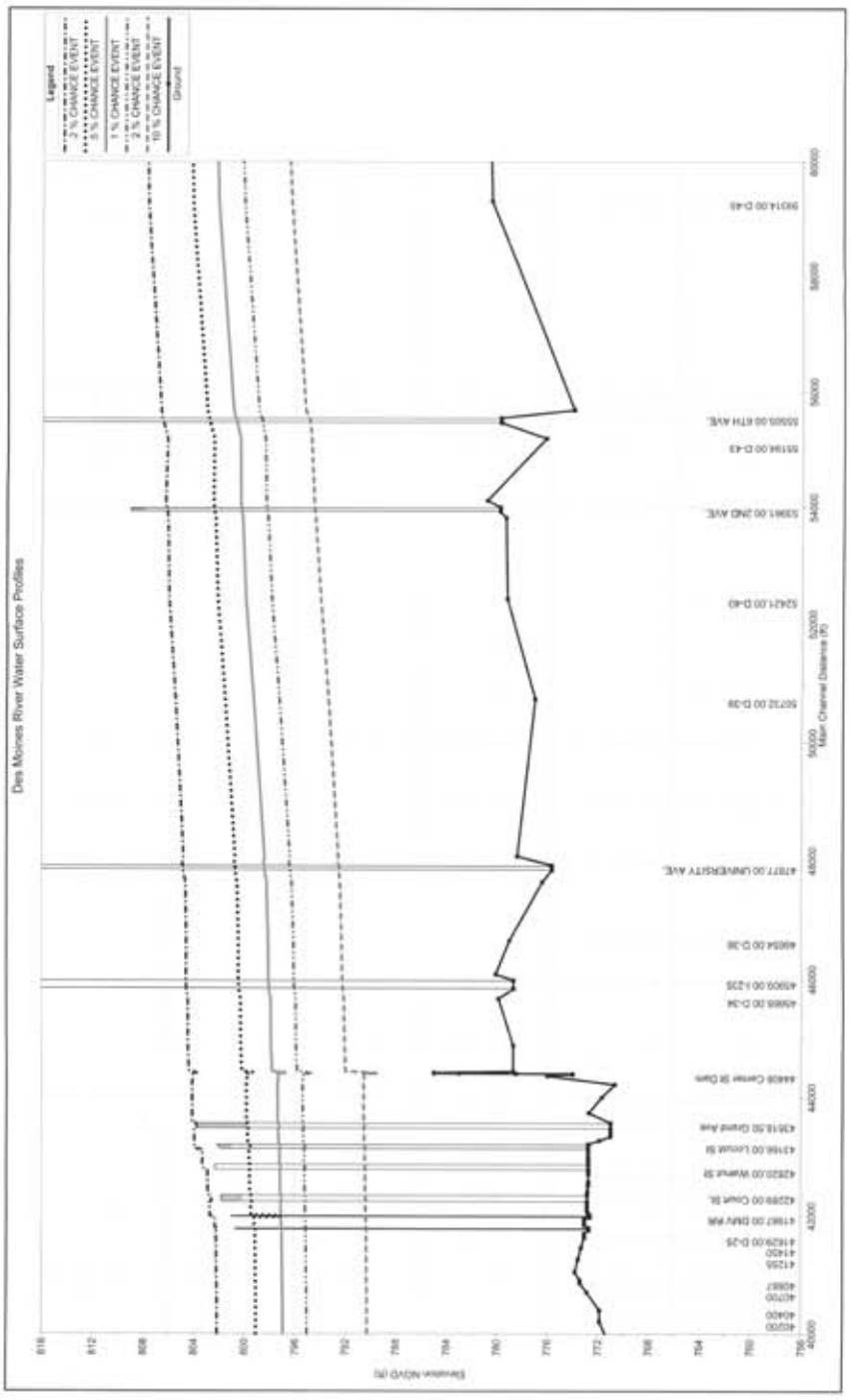

Legend
2 % CHANCE EVENT
5% CHANCE EVENT
1 % CHANCE EVENT
10 % CHANCE EVENT
Ground
Des Moines River Water Surface Profiles
Page 13 Volume 3
Plate A-5
Elevation NGVD (ft)
Main Channel Distance (ft)


Page 14 Volume 3
Des Moines River Water Surface Profiles
Legend
1 % CHANCE EVENT
2 % CHANCE EVENT
5 % CHANCE EVENT
1 % CHANCE EVENT
2 % CHANCE EVENT
10 % CHANCE EVENT
Ground
Elevation NGVD (ft)
Main Channel Distance (ft)
Plate A-6

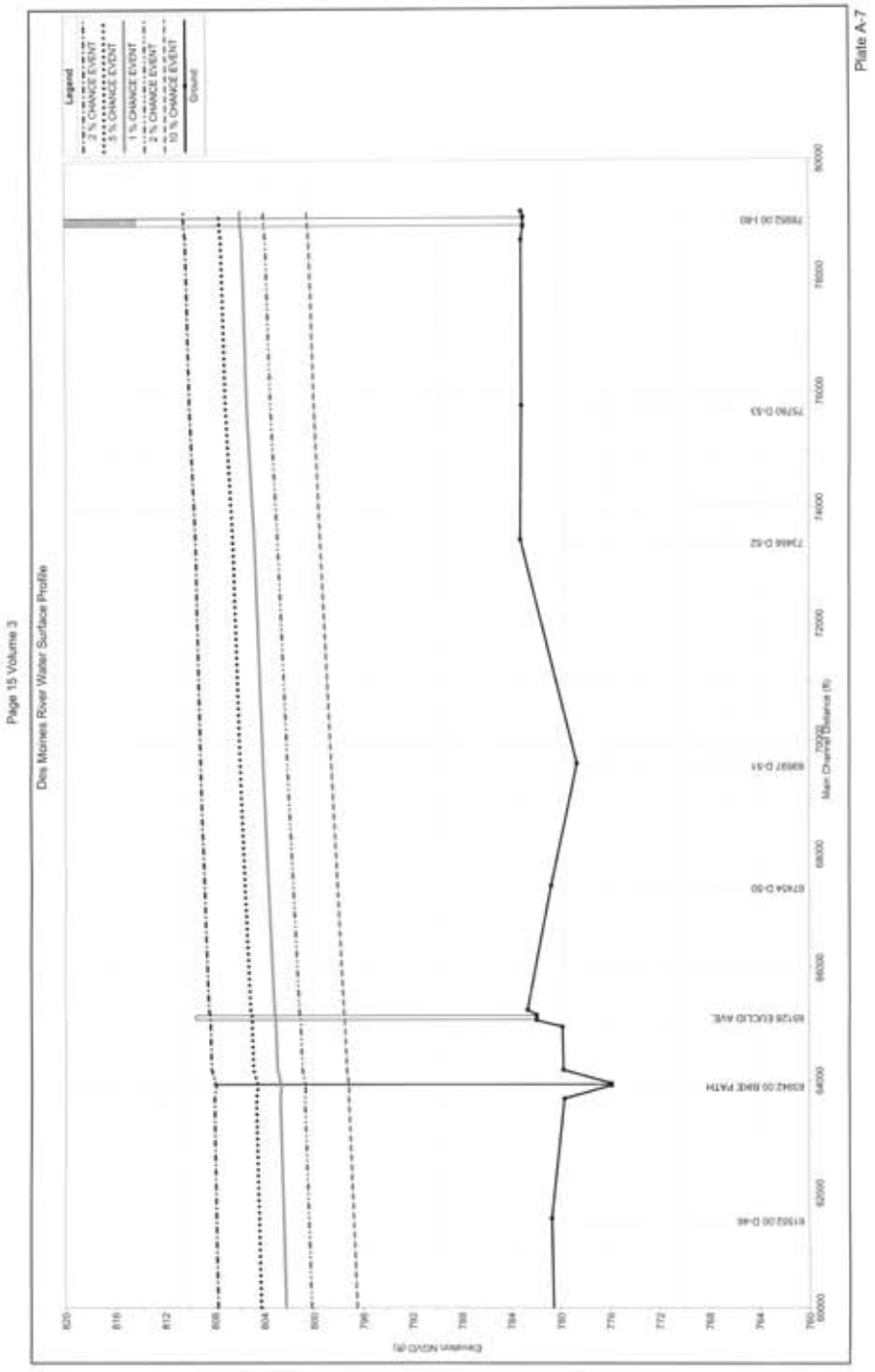
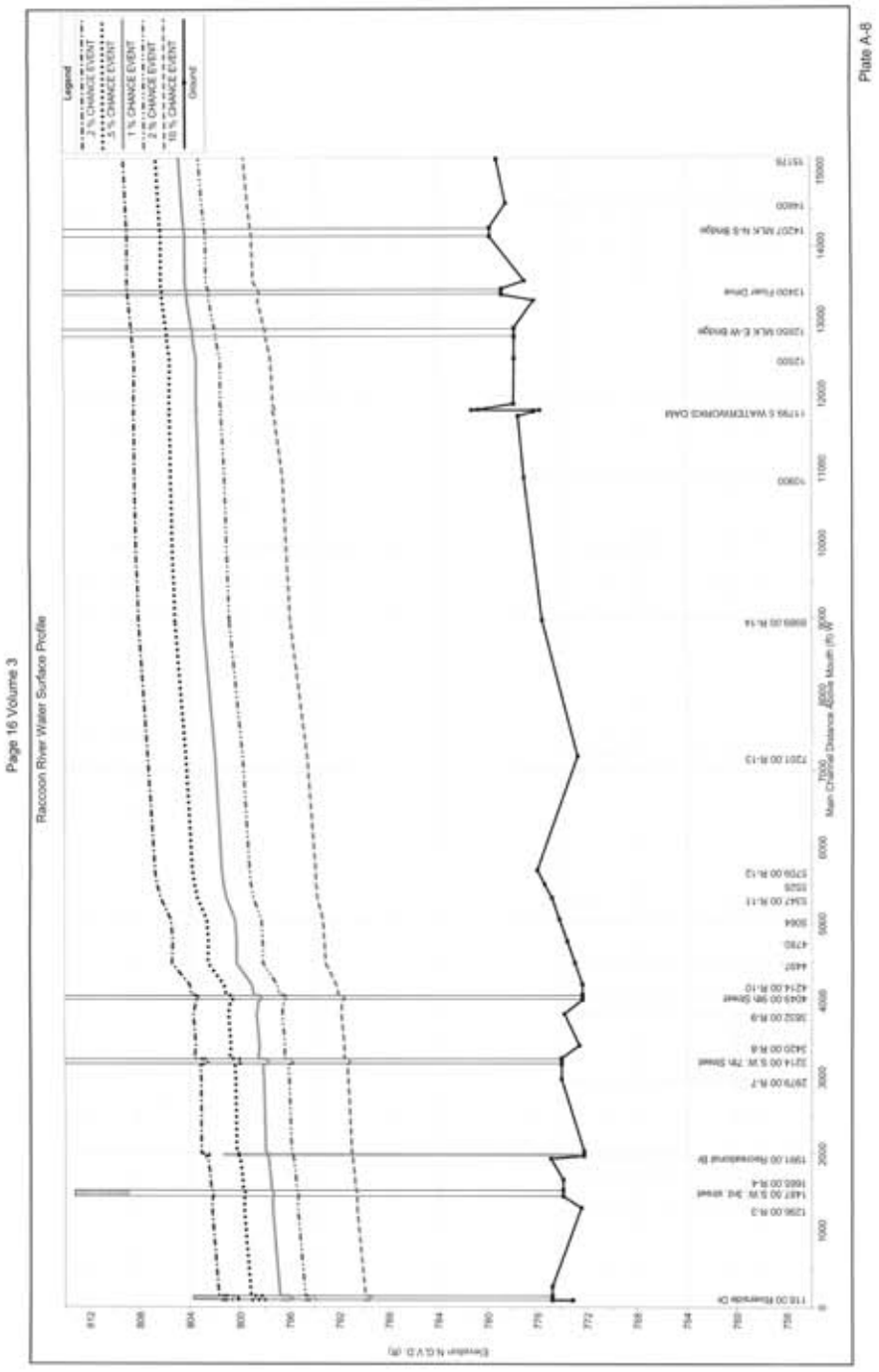

Page 15 Volume 3
Des Moines River Water Surface Profile
Legend
2 % CHANCE EVENT
5 % CHANCE EVENT
1 % CHANCE EVENT
2 % CHANCE EVENT
10 % CHANCE EVENT
Ground
Main Channel Distance (ft)
Elevation NGVD (ft)

Plate A-7


Page 16 Volume 3
Raccoon River Water Surface Profile
Legend
2 % CHANCE EVENT
5 % CHANCE EVENT
1 % CHANCE EVENT
2 % CHANCE EVENT
10 % CHANCE EVENT
Ground
Elevation N.G.V.D. (ft)
Main Channel Distance Above Mouth (ft) W
Plate A-8

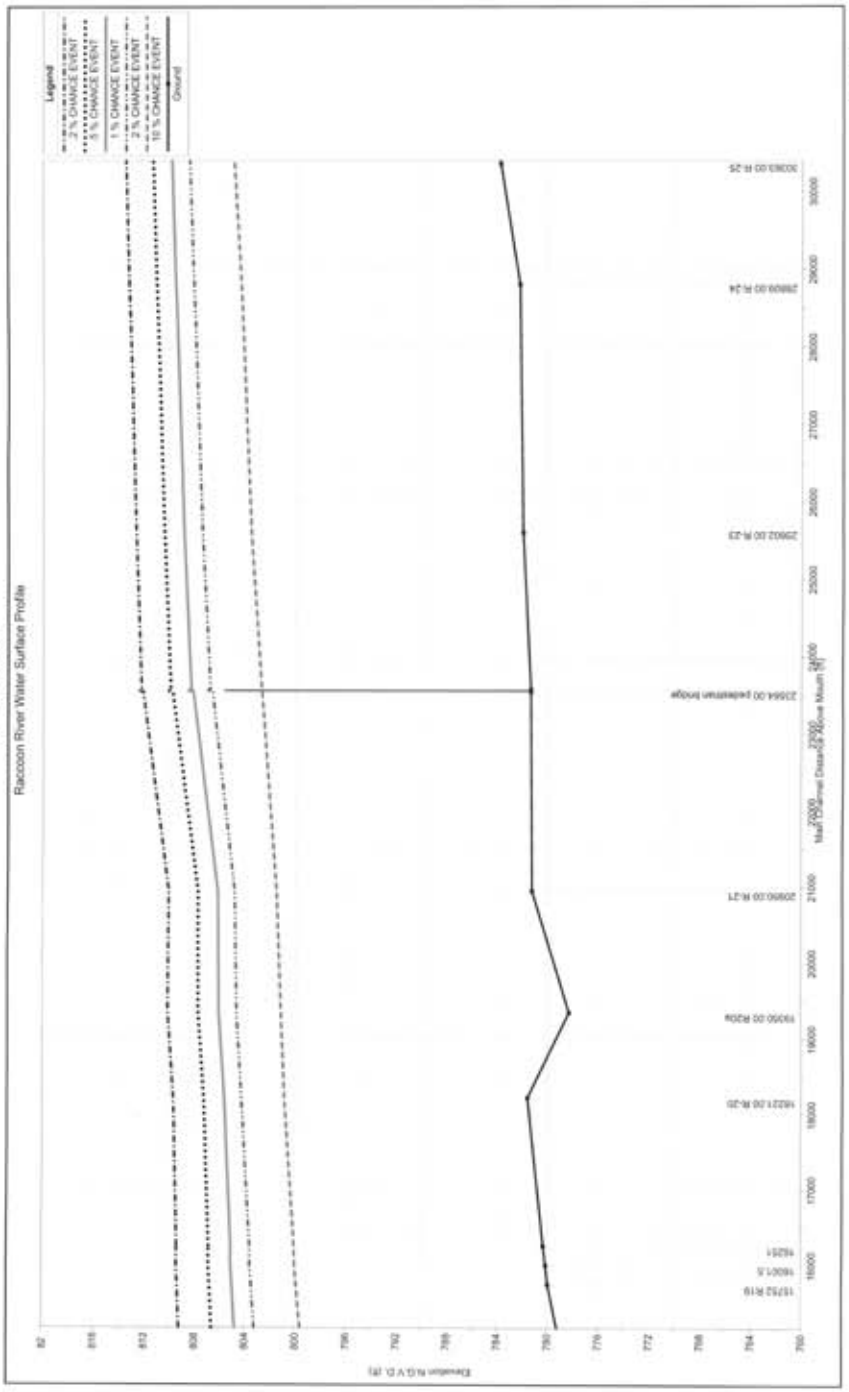

Page 17 Volume 3
Raccoon River Water Surface Profile
Legend
2 % CHANCE EVENT
5 % CHANCE EVENT
1 % CHANCE EVENT
2 % CHANCE EVENT
10 % CHANCE EVENT
Ground
Elevation N.G.V.D. (ft)
Main Channel Distance Above Mouth (ft)
15752.R19
16001.5
16251
16221.00 R.20
19050.00 R20a
20990.00 R.21
23564.00 pedestrian bridge
29602.00 R.23
29809.00 R.24
30083.00 R.25

Plate A-9

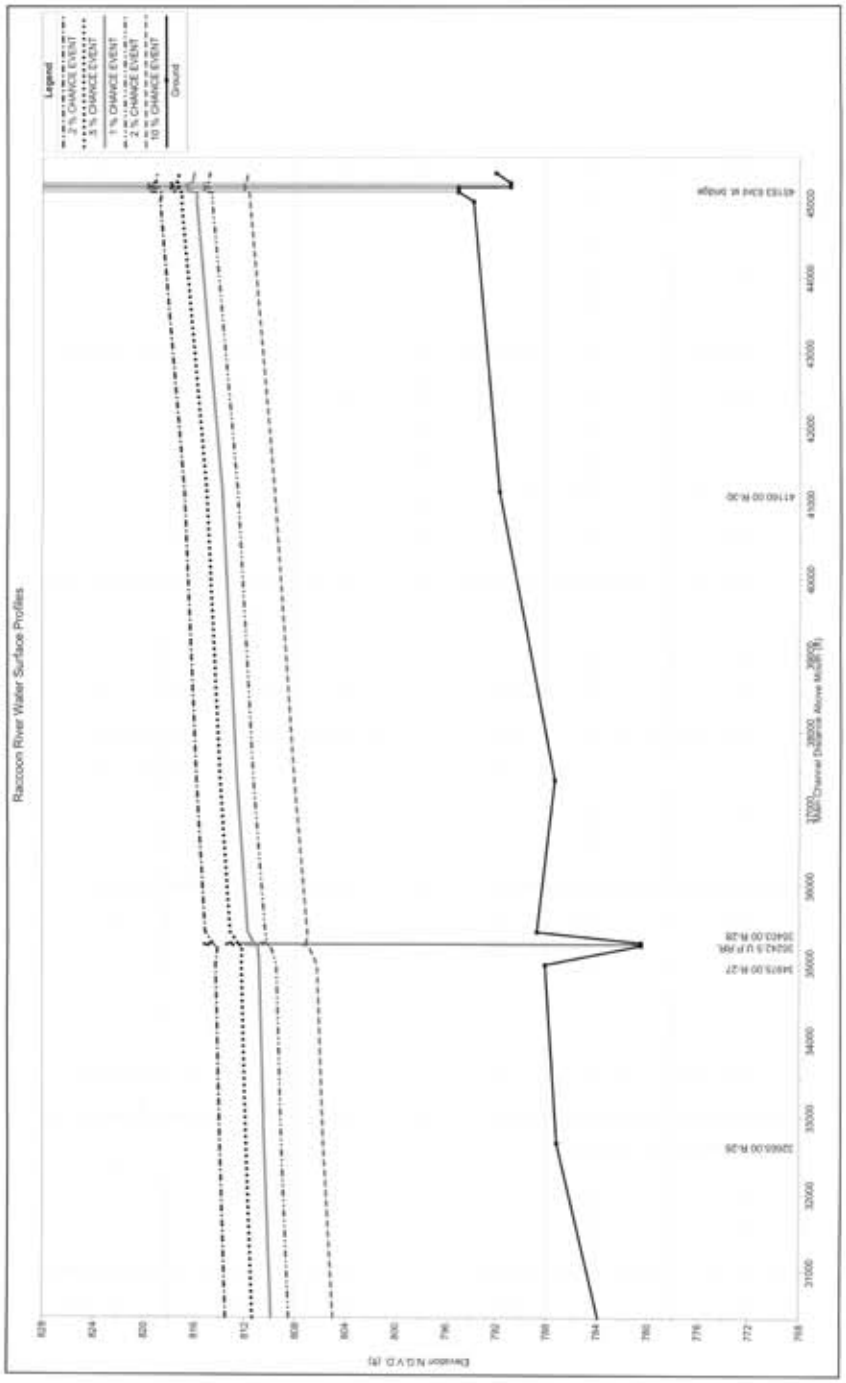


Plate A-10
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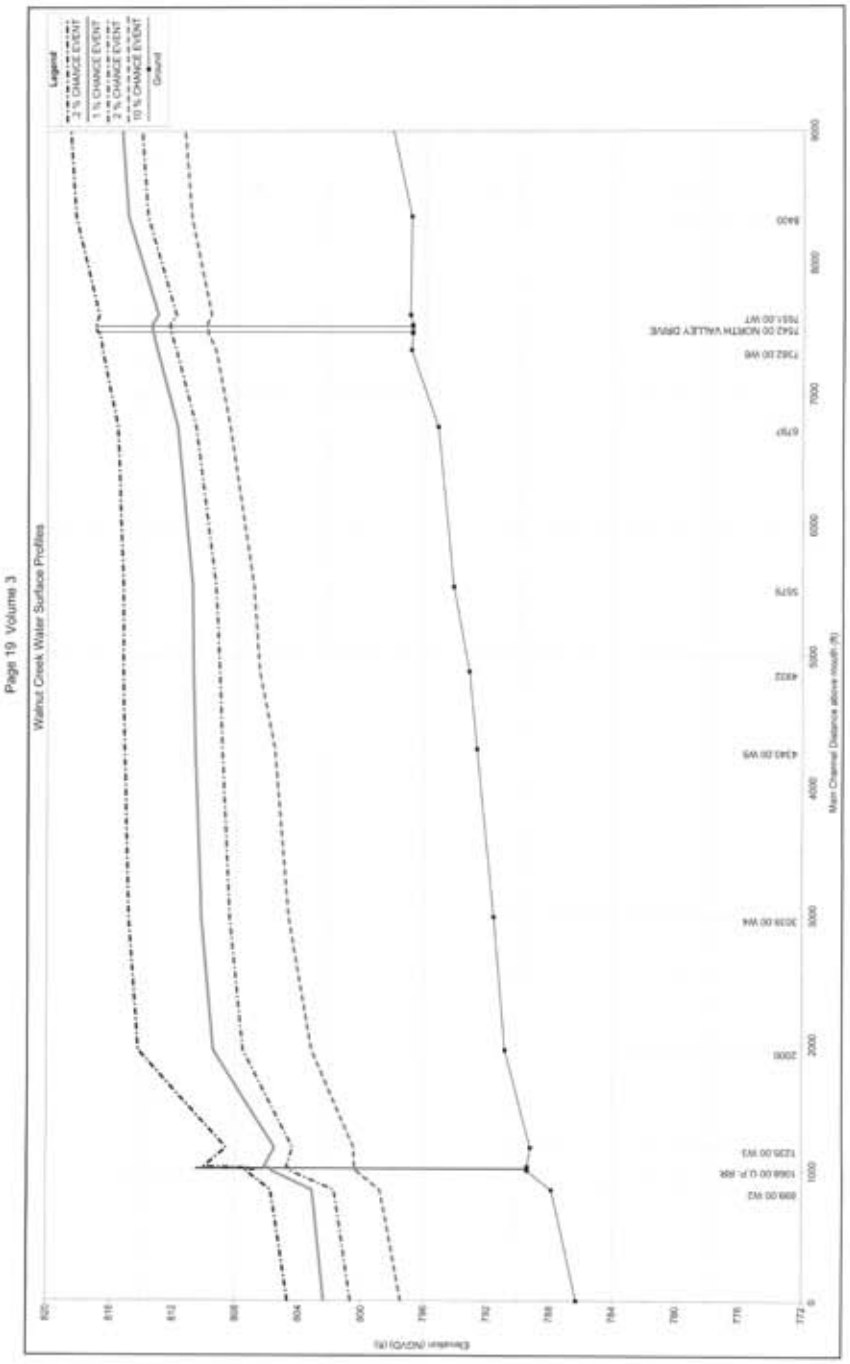
Raccoon River Water Surface Profiles
Legend
2 % CHANCE EVENT
5 % CHANCE EVENT
1 % CHANCE EVENT
2 % CHANCE EVENT
10 % CHANCE EVENT
Ground
Elevation N.G.V.D. (ft)
Channel Distance Above Mouth (ft)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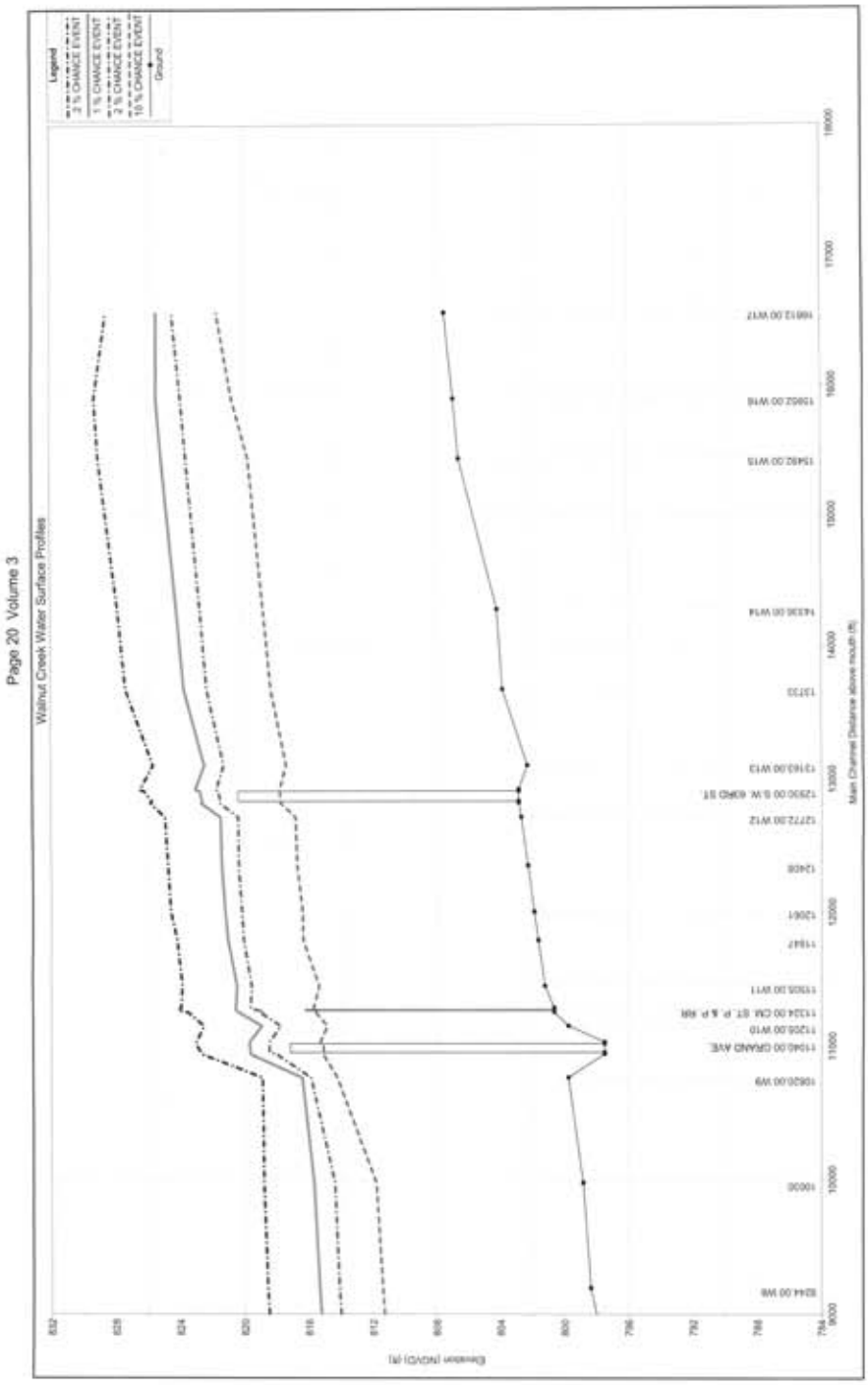
Walnut Creek Water Surface Profiles
Legend
2 % CHANGE EVENT
1 % CHANGE EVENT
Ground
Elevation (NGVD) (ft)
Main Channel Distance above mouth (ft)
Plate A-11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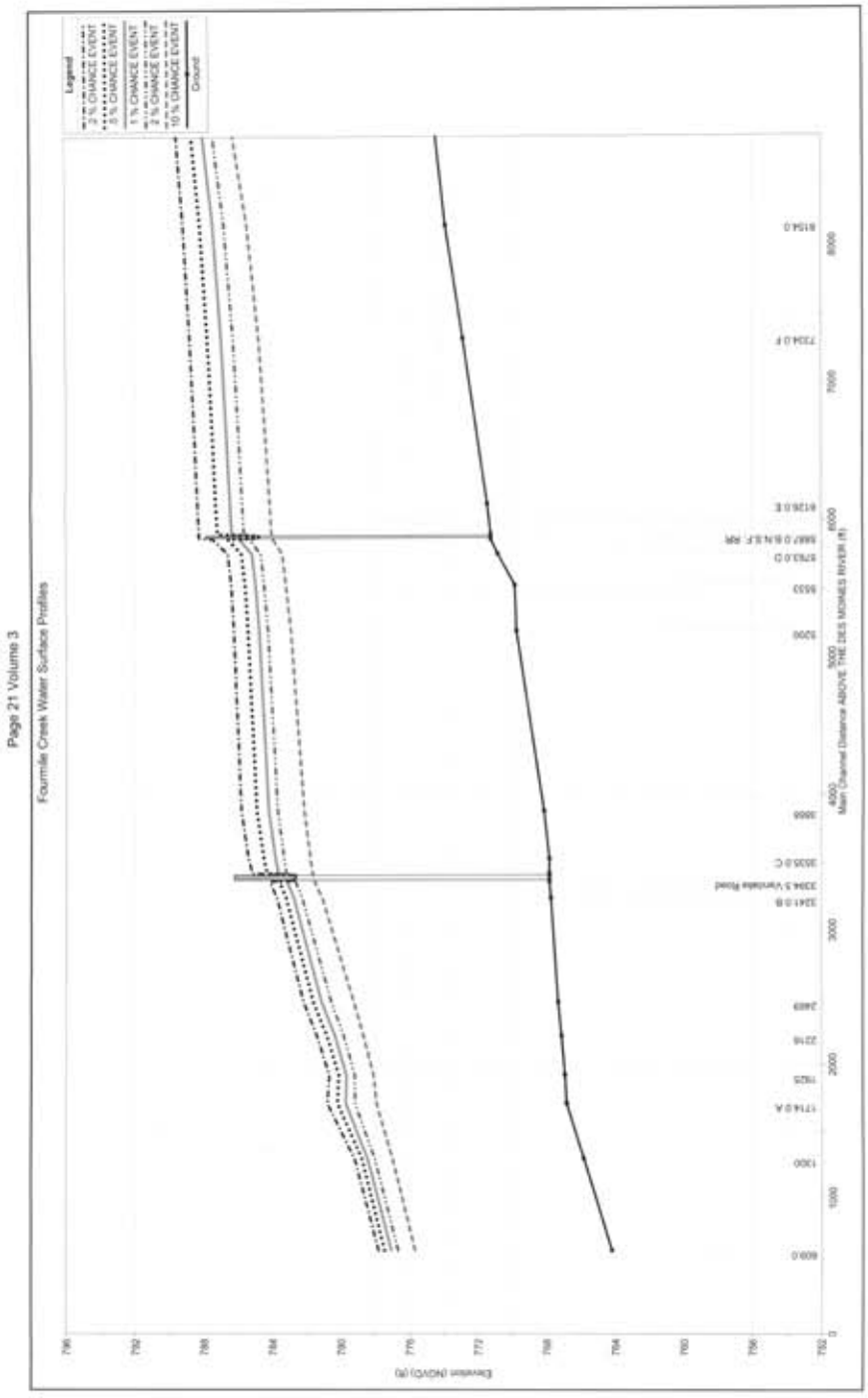
Walnut Creek Water Surface Profiles
Legend
2 % CHANGE EVENT
1% CHANGE EVENT
2 % CHANGE EVENT
10 % CHANGE EVENT
Ground
Elevation (NGVD) (ft)
Main Channel Distance above mouth (ft)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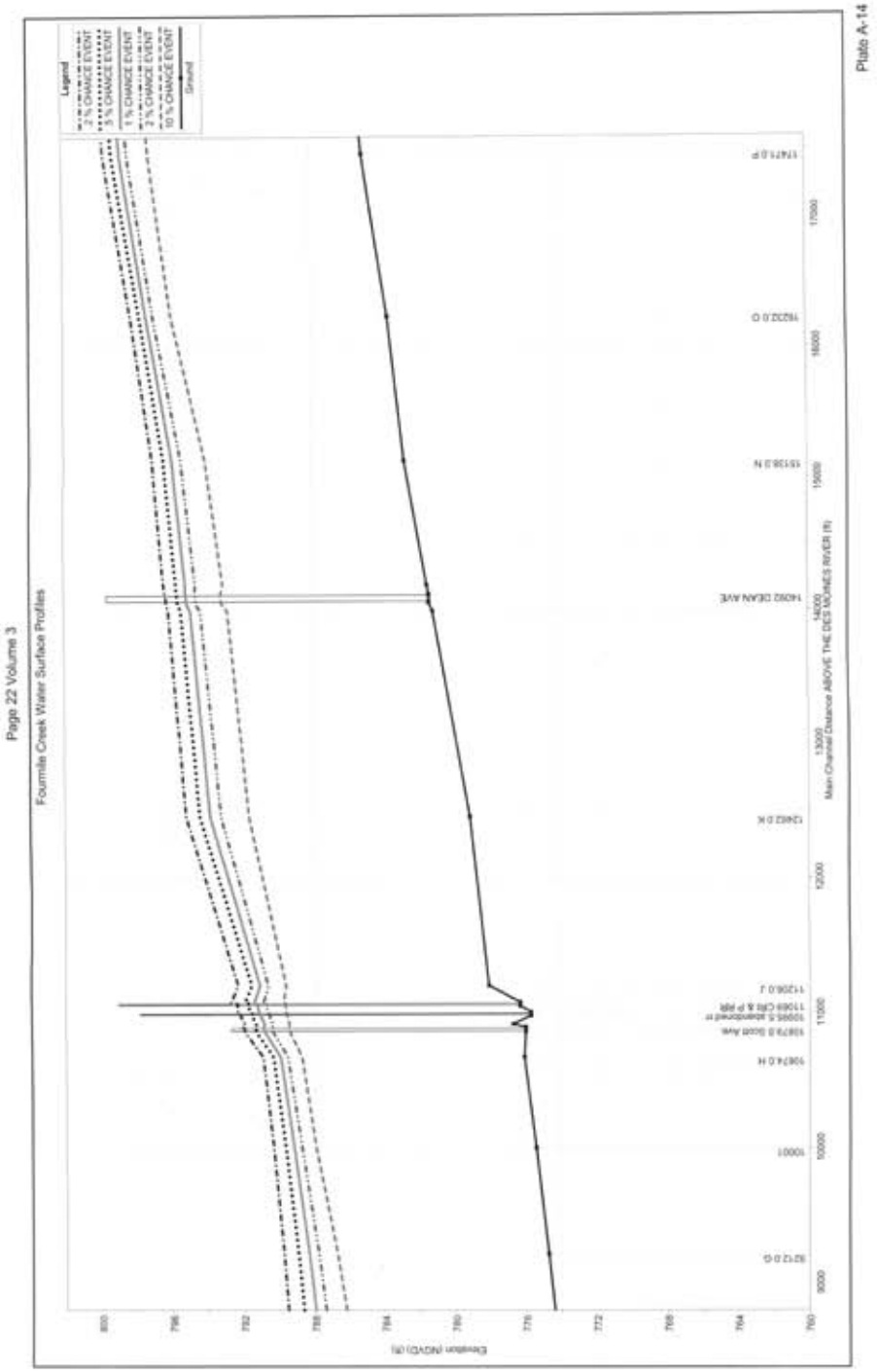
Fourmile Creek Water Surface Profiles
Plate A-13
Legend
2 % CHANCE EVENT
1 % CHANCE EVENT
0.2 % CHANCE EVENT
10 % CHANCE EVENT
Ground
Elevation (NGVD) (ft)
Main Channel Distance ABOVE THE DES MOINES RIVER (ft)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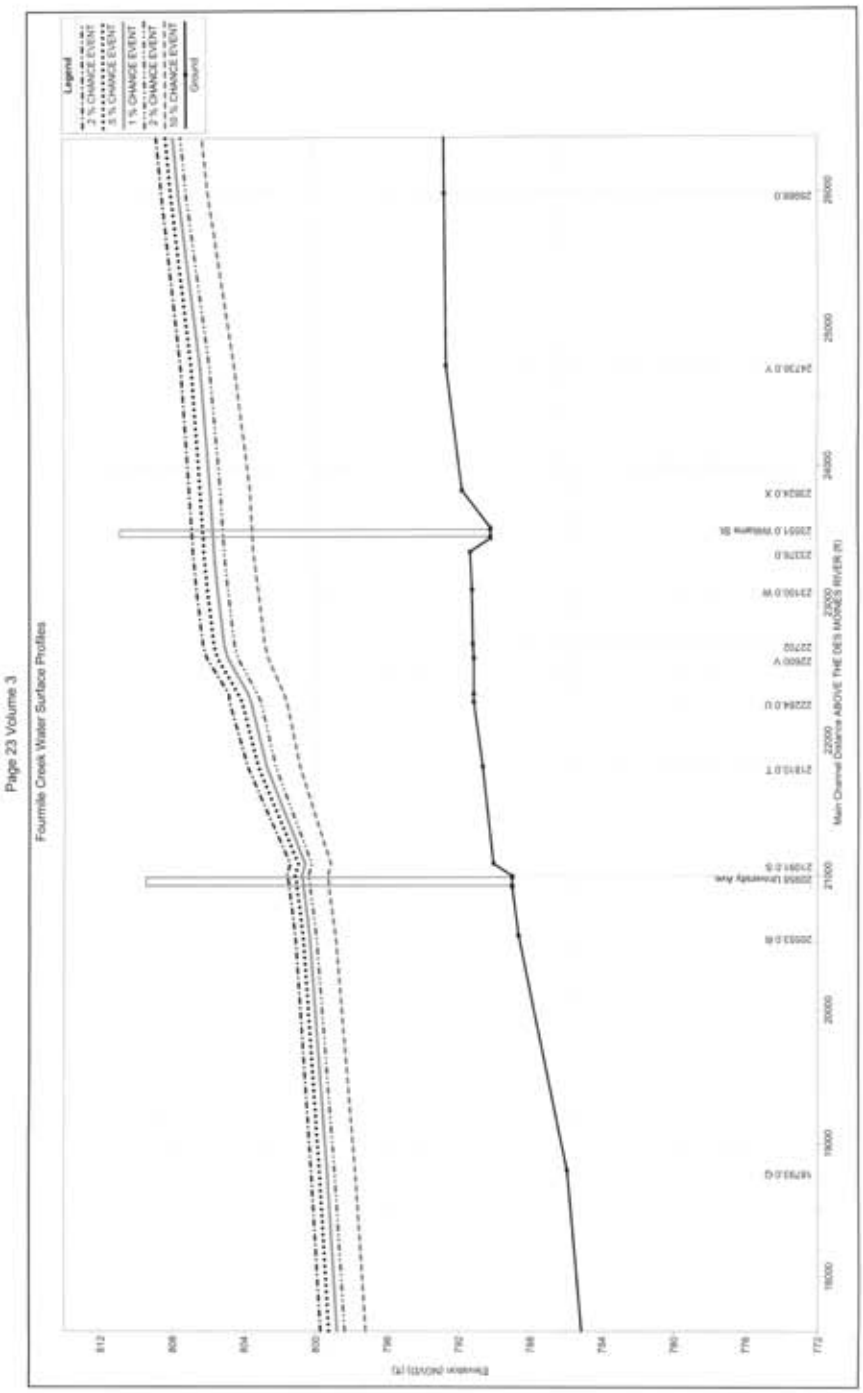
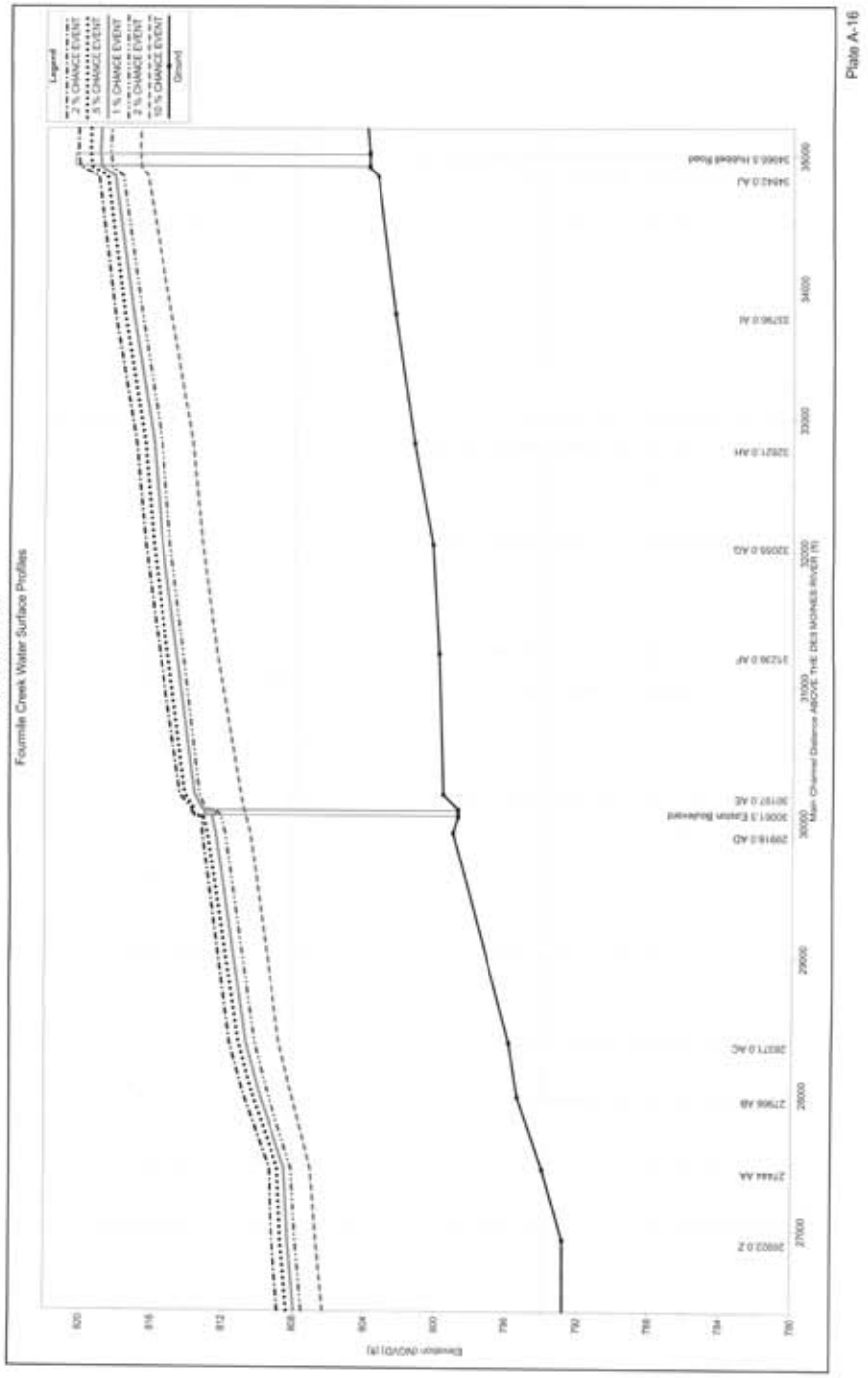
Fourmile Creek Water Surface Profiles
Legend
2 % CHANCE EVENT
5 % CHANCE EVENT
1 % CHANCE EVENT
2 % CHANCE EVENT
10 % CHANCE EVENT
Ground
Elevation (NGVD) (ft)
Main Channel Distance ABOVE THE DES MOINES RIVER (ft)
Plate A-14


Page 23 Volume 3
Fourmile Creek Water Surface Profiles
Legend
2 % CHANCE EVENT
5 % CHANCE EVENT
10 % CHANCE EVENT
1 % CHANCE EVENT
2 % CHANCE EVENT
10 % CHANCE EVENT
Ground
Elevation (NGVD) (ft)
Main Channel Distance ABOVE THE DES MOINES RIVER (ft)
Plate A-15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Fourmile Creek Water Surface Profiles
Plate A-16
Legend
2 % CHANGE EVENT
3 % CHANGE EVENT
1 % CHANGE EVENT
2 % CHANGE EVENT
10 % CHANGE EVENT
Ground
Elevation (NGVD) (ft)
Main Channel Distance ABOVE THE DES MOINES RIVER (ft)

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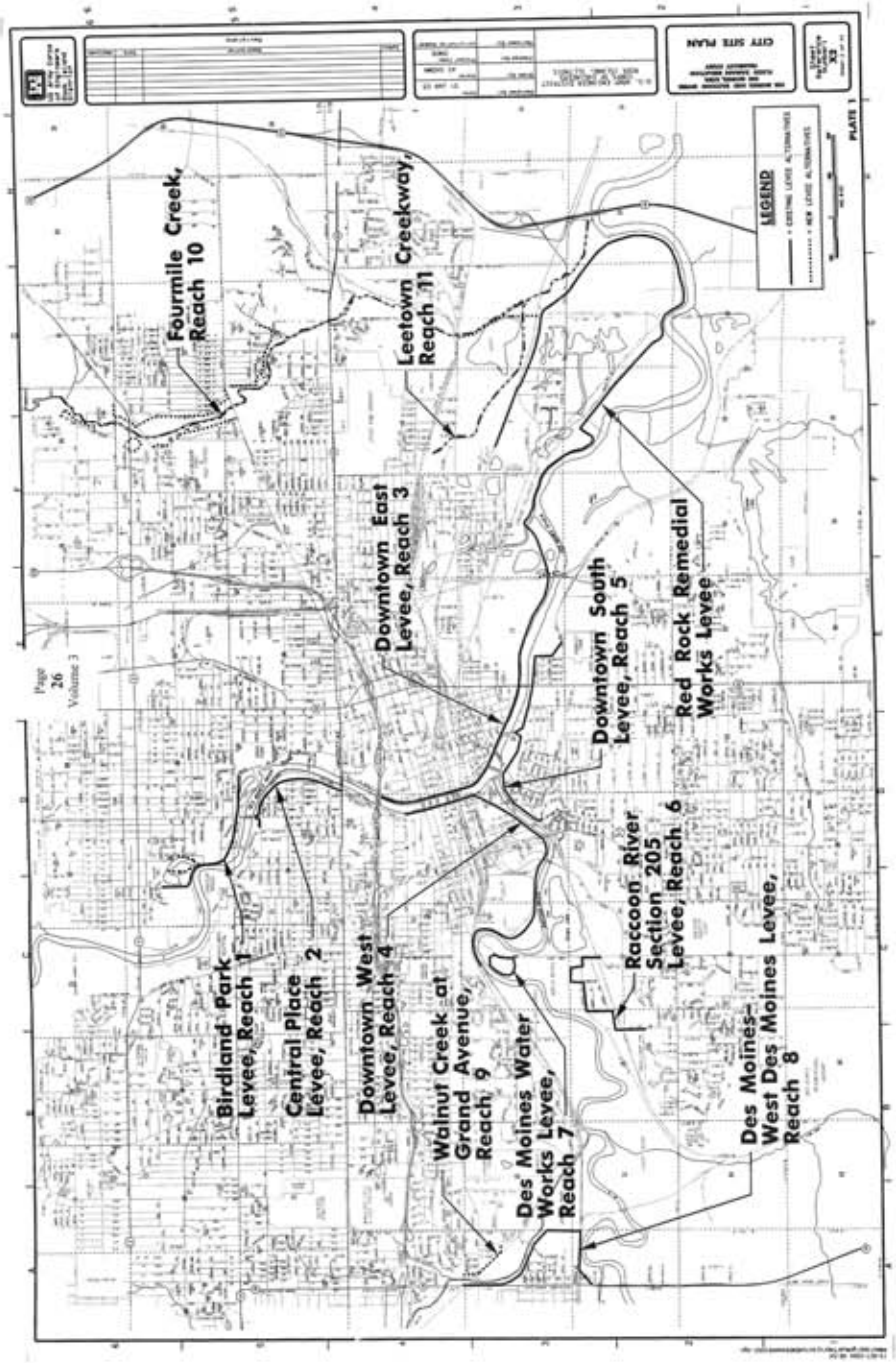
Fourmile Creek Water Surface Profiles
Legend
2 % CHANCE EVENT
5 % CHANCE EVENT
1 % CHANCE EVENT
2 % CHANCE EVENT
10 % CHANCE EVENT
Ground
Elevation (NGVD) (ft)
Main Channel Distance ABOVE THE DES MOINES RIVER (ft)
Plate A-17


Fourmile Creek, Reach 10
Leetown Creekway, Reach 11
Downtown East Levee, Reach 3
Downtown South Levee, Reach 5
Red Rock Remedial Works Levee
Raccoon River Section 205 Levee, Reach 6
Des Moines Levee, West Des Moines Reach 8
Des Moines Water Works Levee, Reach 7
Walnut Creek at Grand Avenue, Reach 9
Downtown West Levee, Reach 4
Central Place Levee, Reach 2
Birdland Park Levee, Reach 1
LEGEND
CITY SITE PLAN
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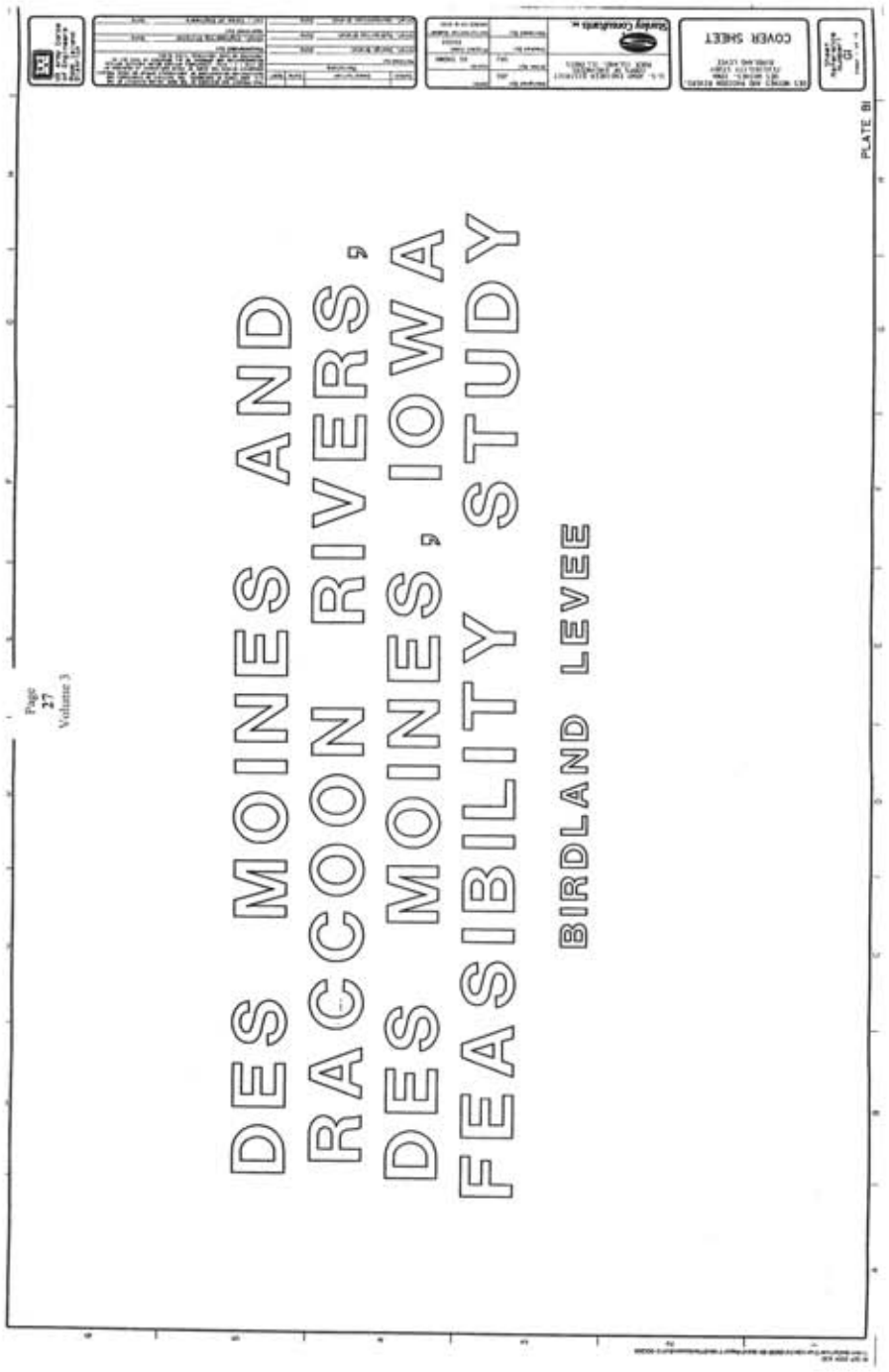
DES MOINES AND
RACCOON RIVERS,
DES MOINES, IOWA
FEASIBILITY STUDY
BIRDLAND LEVEE
COVER SHEET
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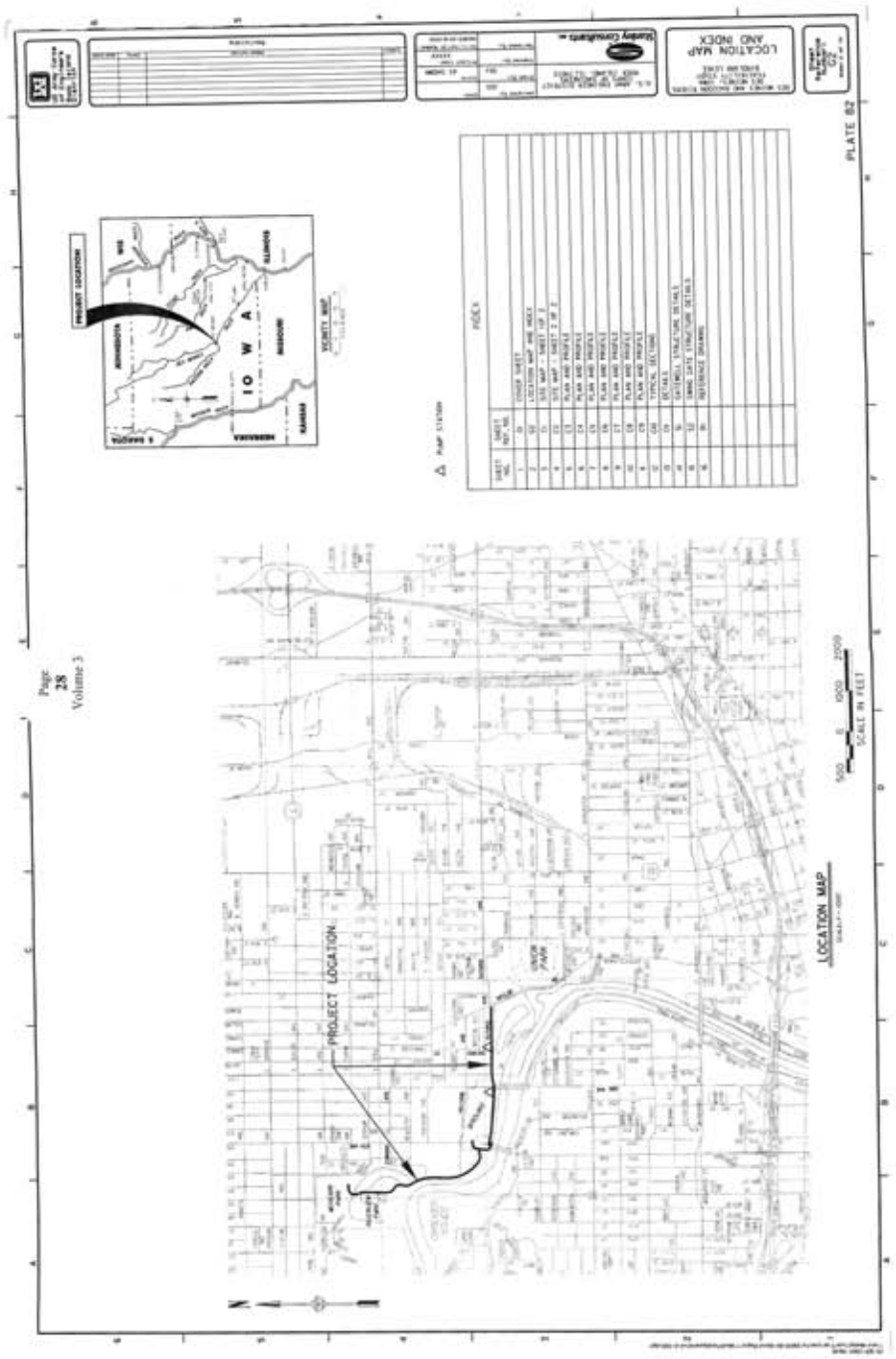
LOCATION MAP AND INDEX
PLATE B2
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PROJECT LOCATION
LOCATION MAP
SCALE IN FEET
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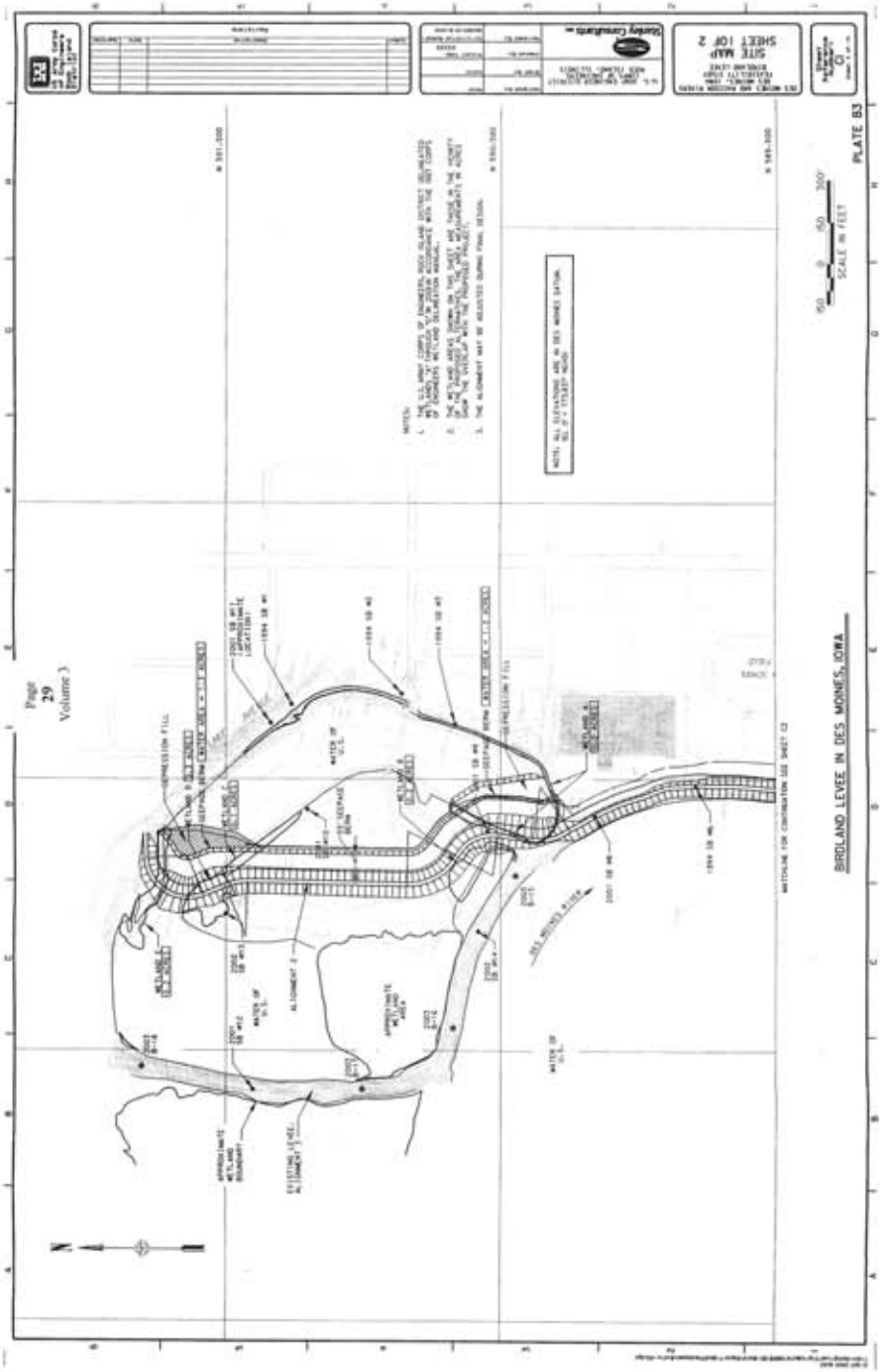
PLATE B3
BIRDLAND LEVEE IN DES MOINES, IOWA
SCALE in FEET
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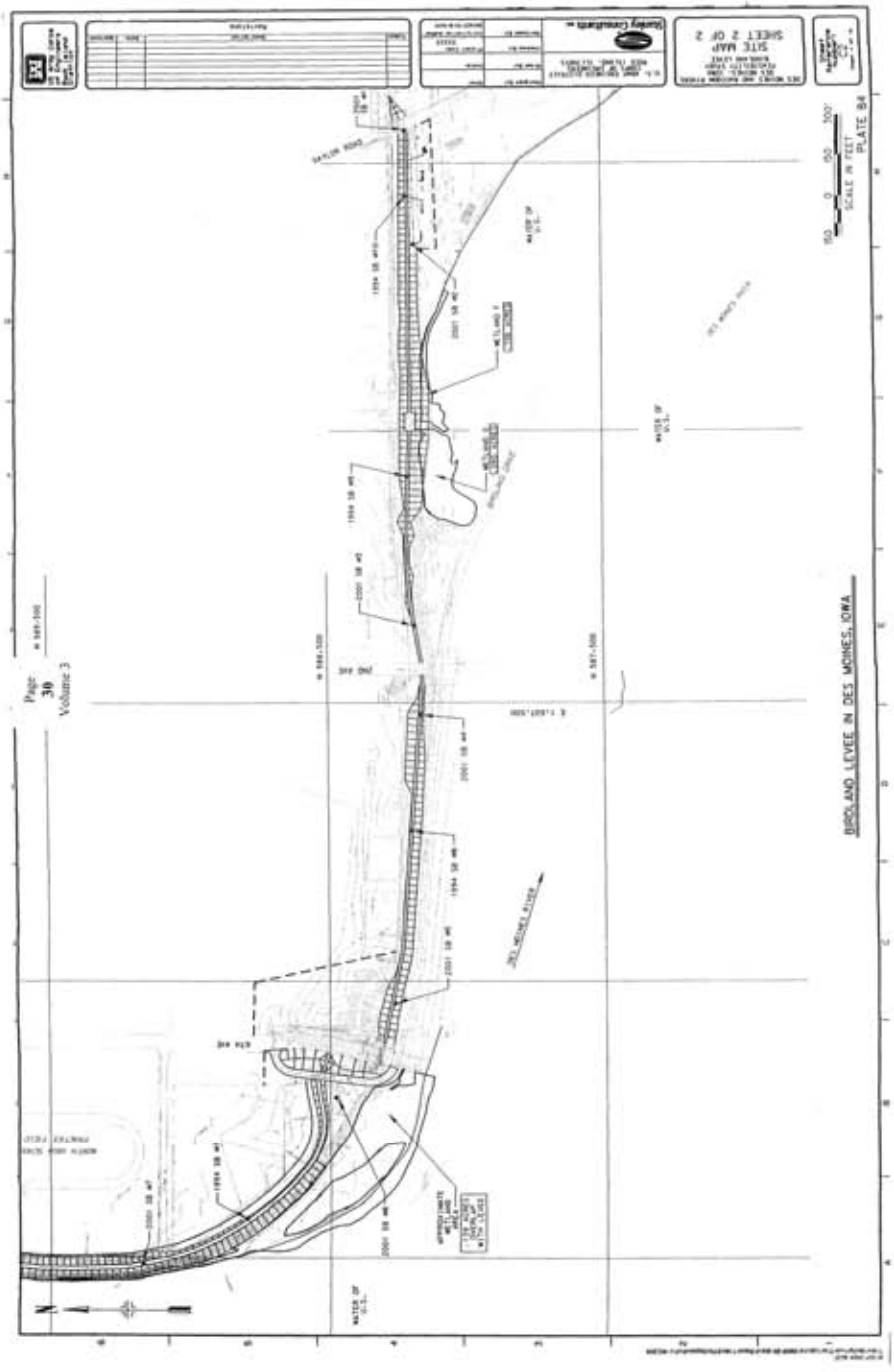
BIROLAND LEVEE IN DES MOINES, IOWA
PLATE 84
SCALE IN FEET
SITE MAP
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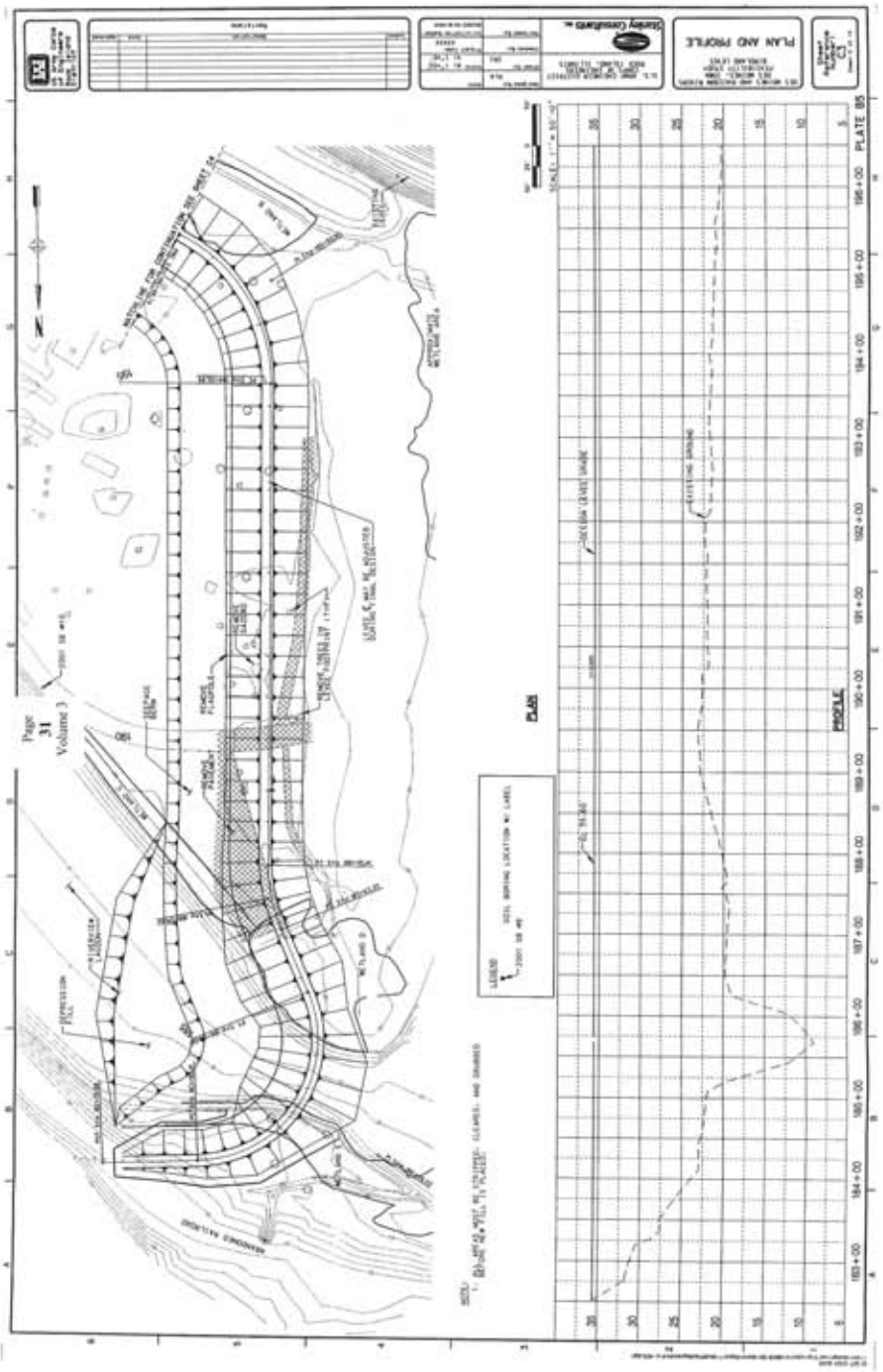
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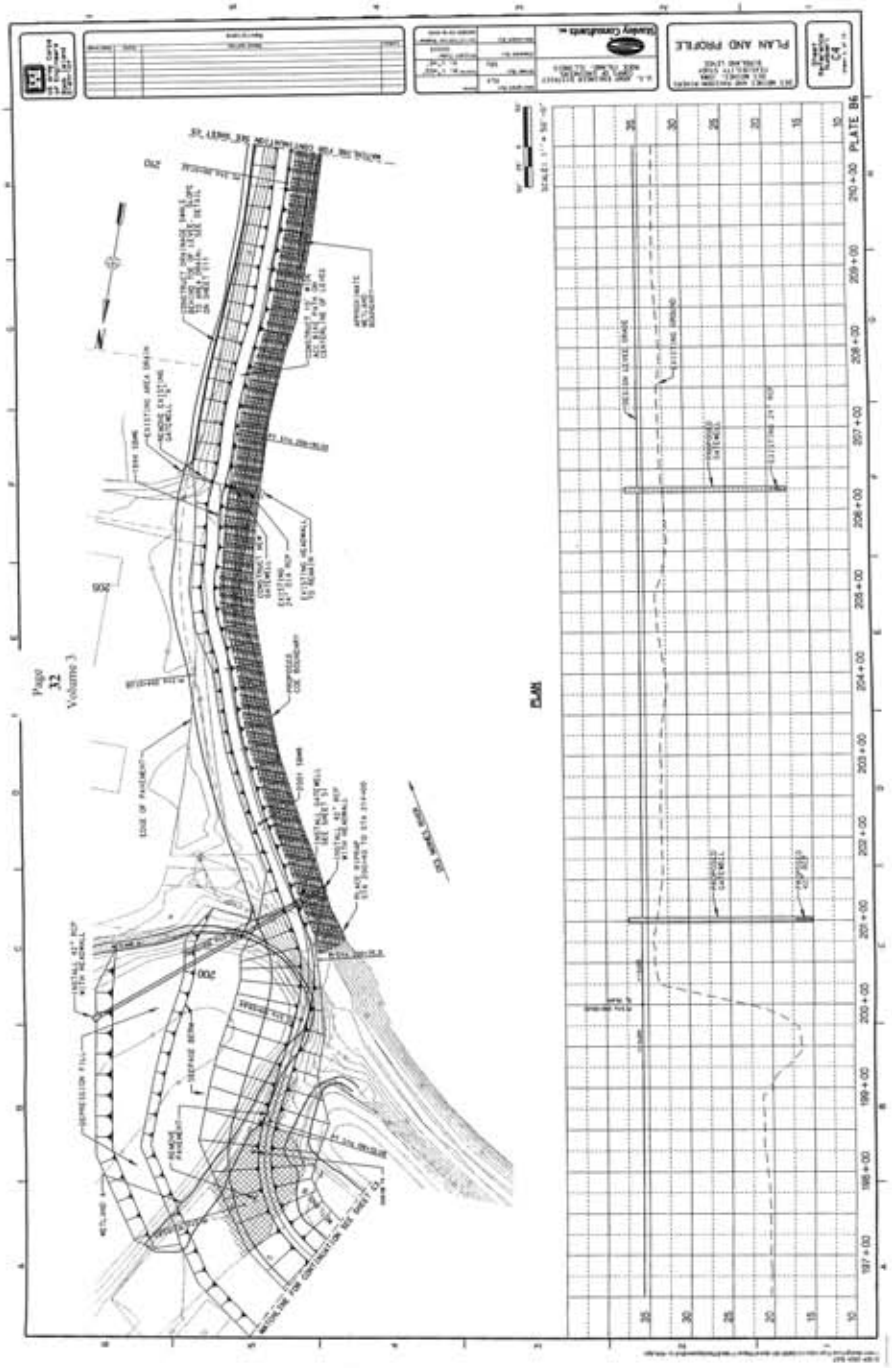
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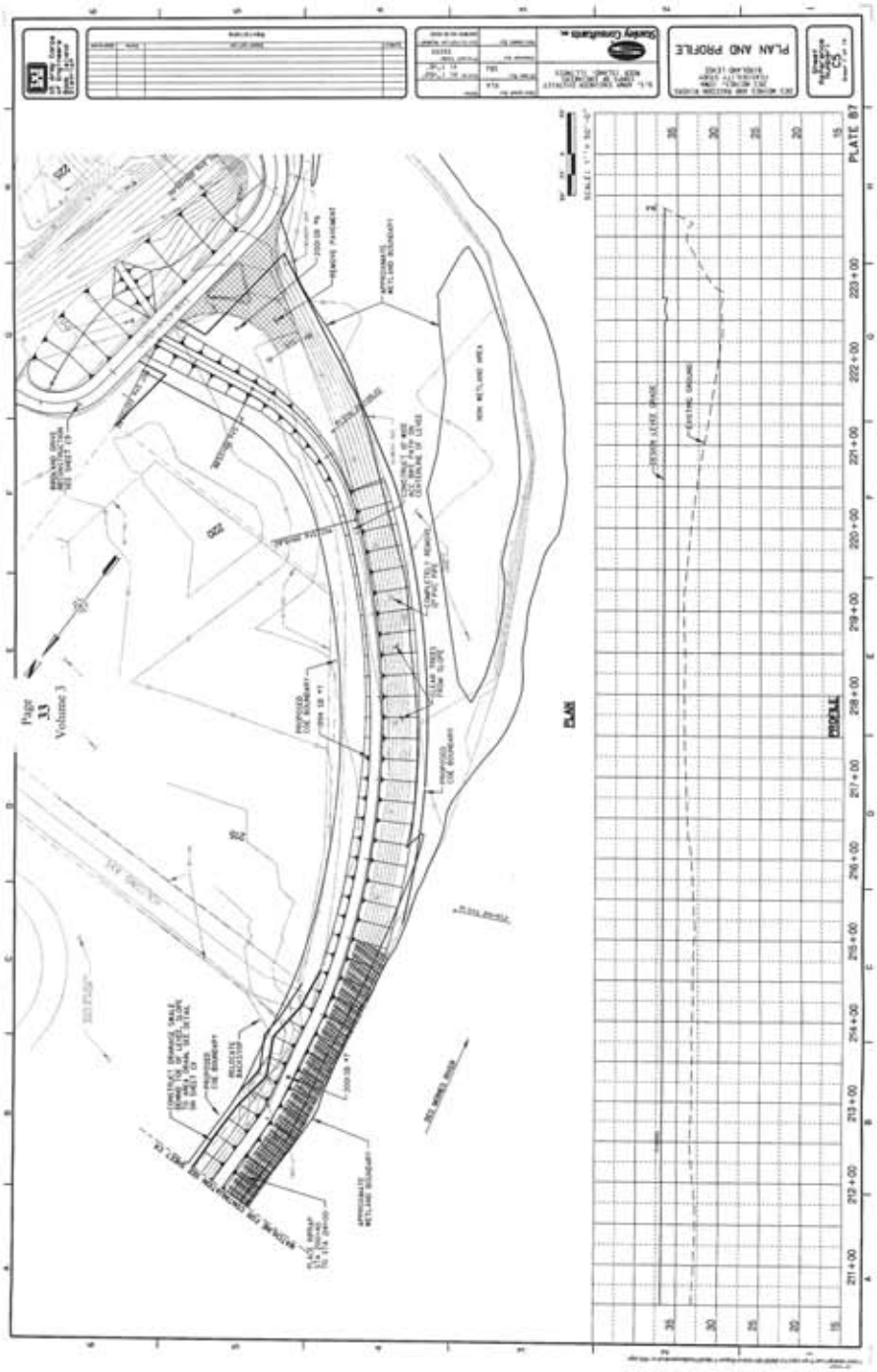
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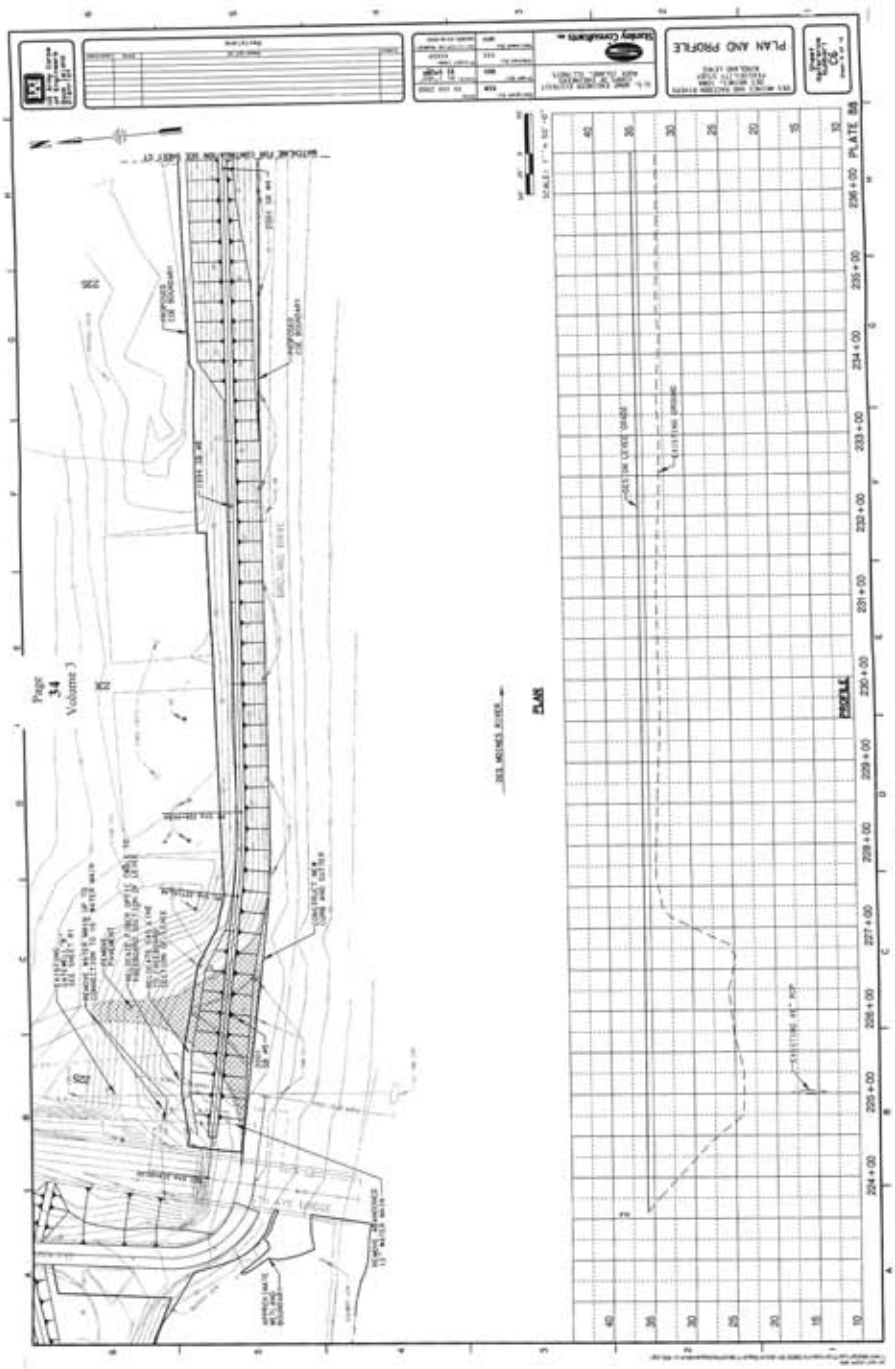
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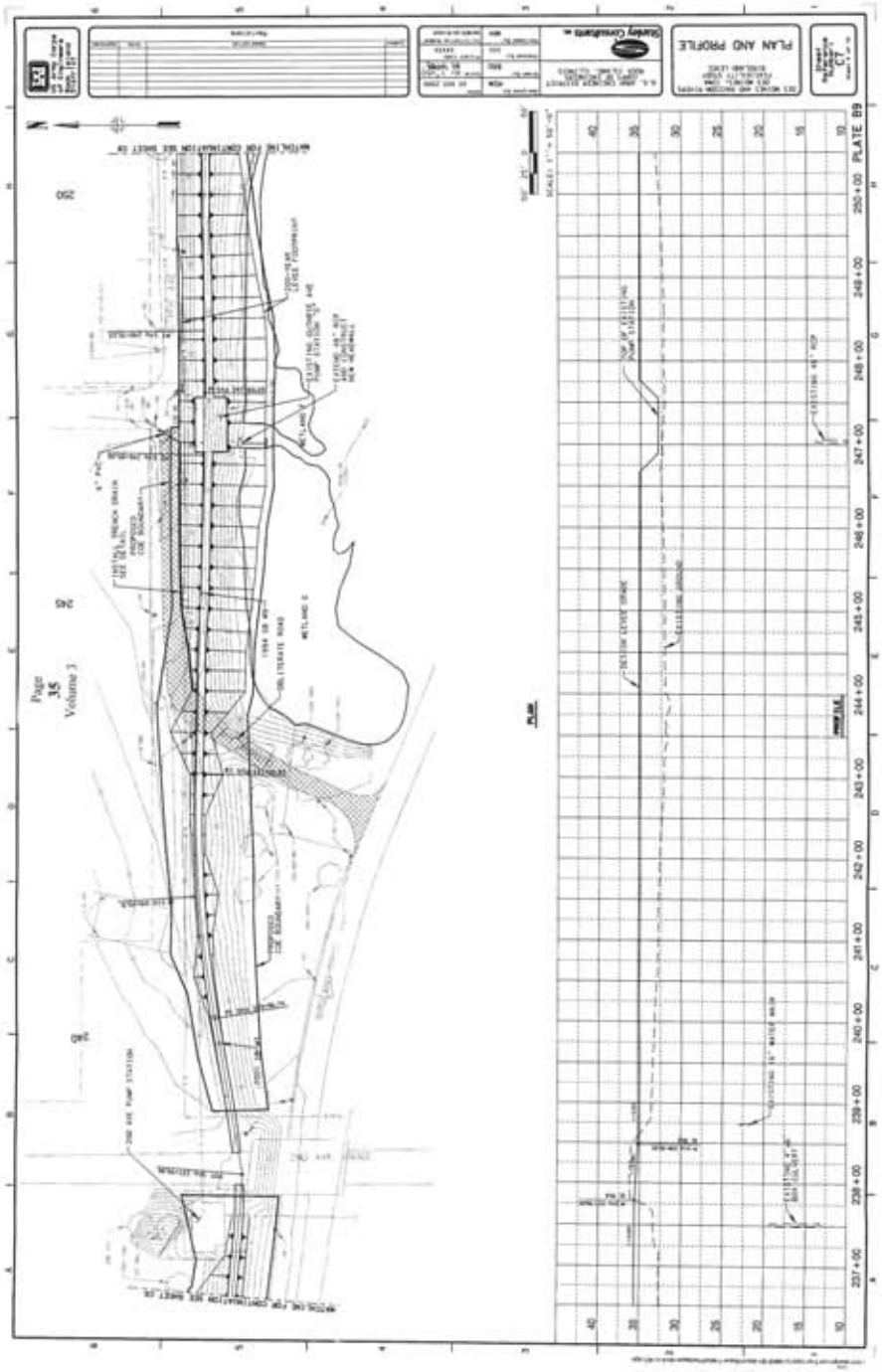
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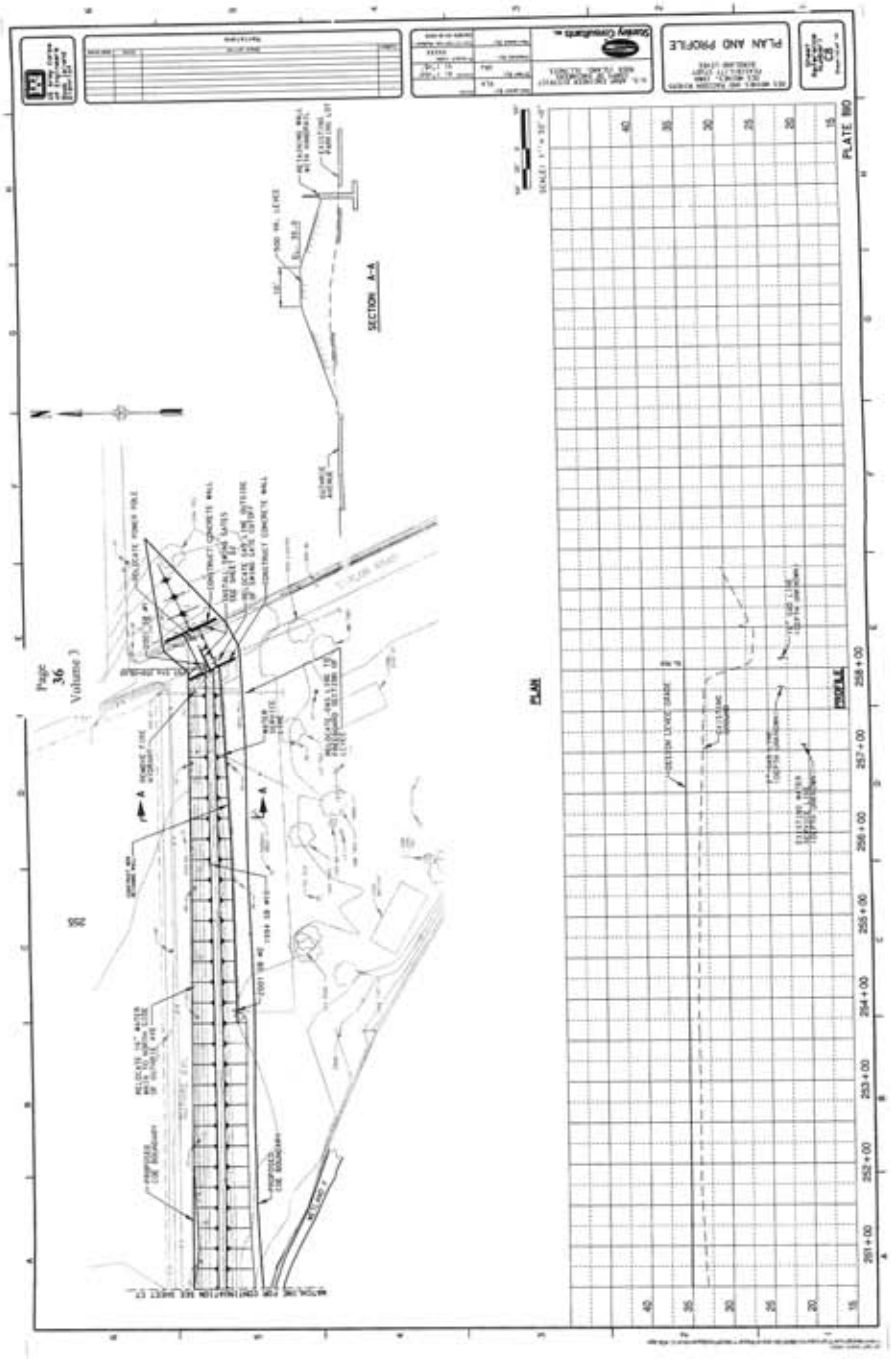
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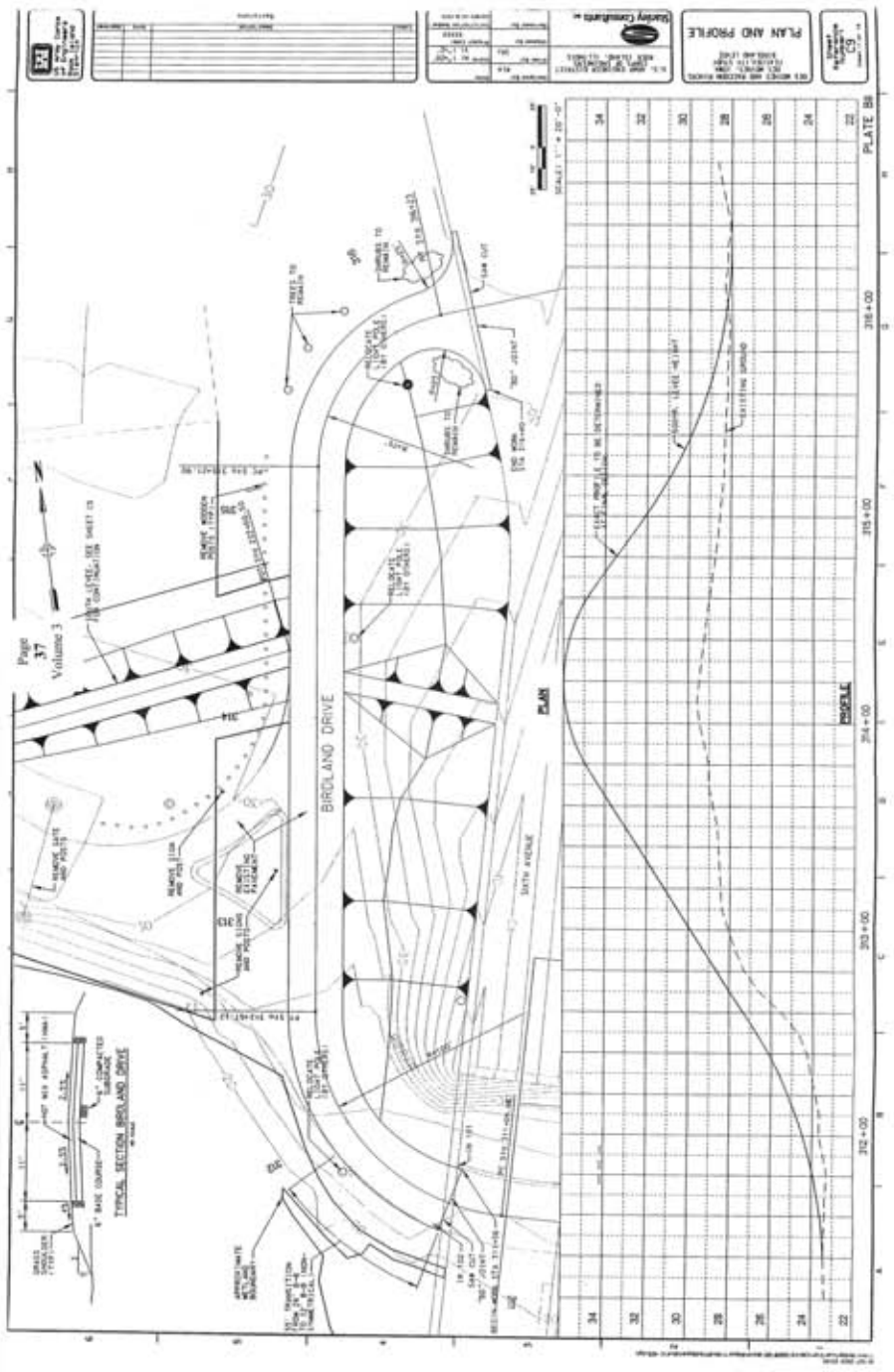
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PLATE 88
BIRDLAND DRIVE
SIXTH AVENUE
PLAN
PROFILE
TYPICAL SECTION BIRDLAND DRIVE
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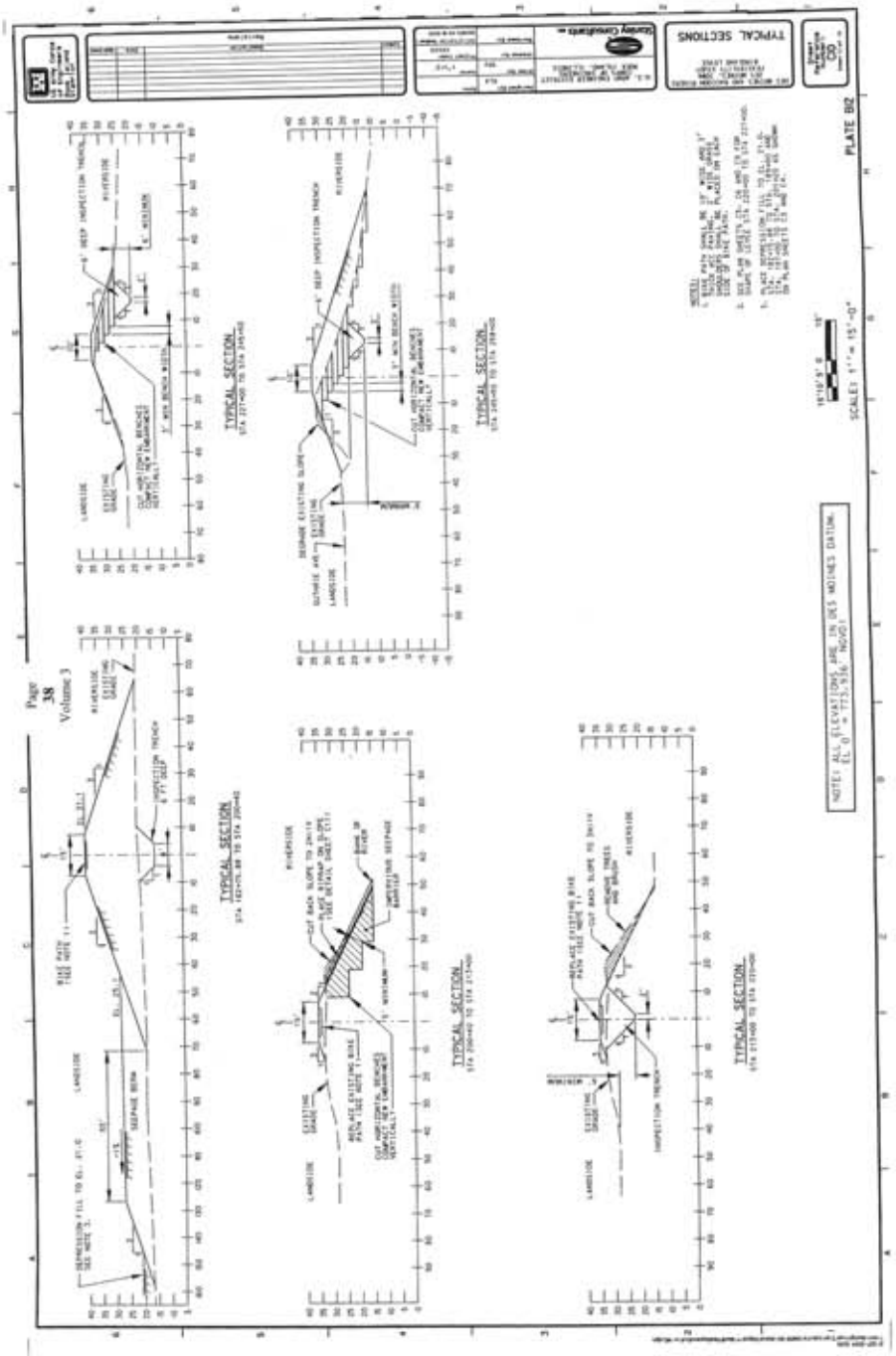
TYPICAL SECTIONS
PLATE B2
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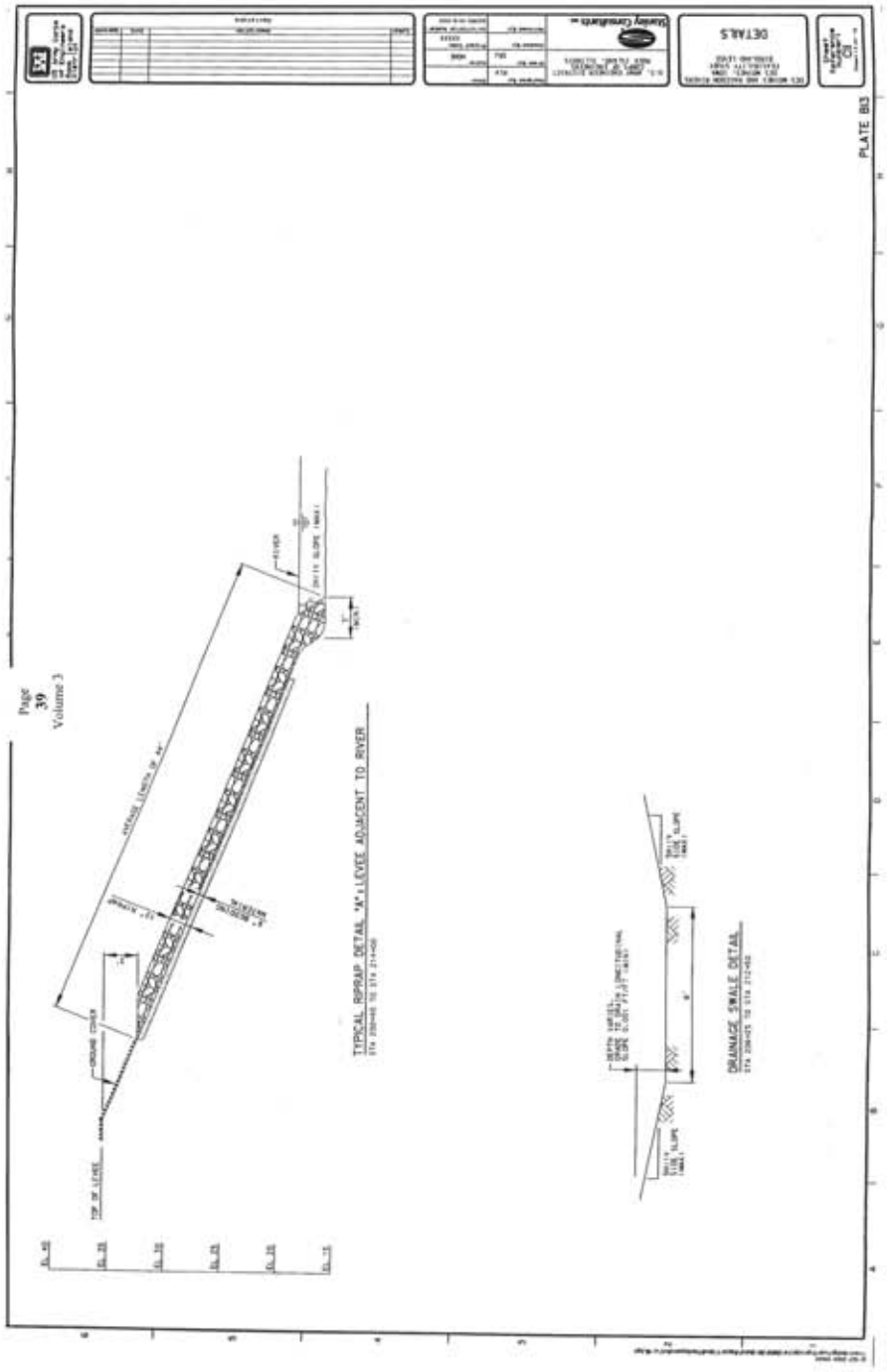
TYPICAL SECTION
TYPICAL SECTION
TYPICAL SECTION
TYPICAL SECTION
TYPICAL SECTION
NOTE: ALL ELEVATIONS ARE IN DES MOINES DATUM.
SCALE: 1" = 15'-0"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DETAILS
TYPICAL RIPRAP DETAIL "A" LEVEE ADJACENT TO RIVER
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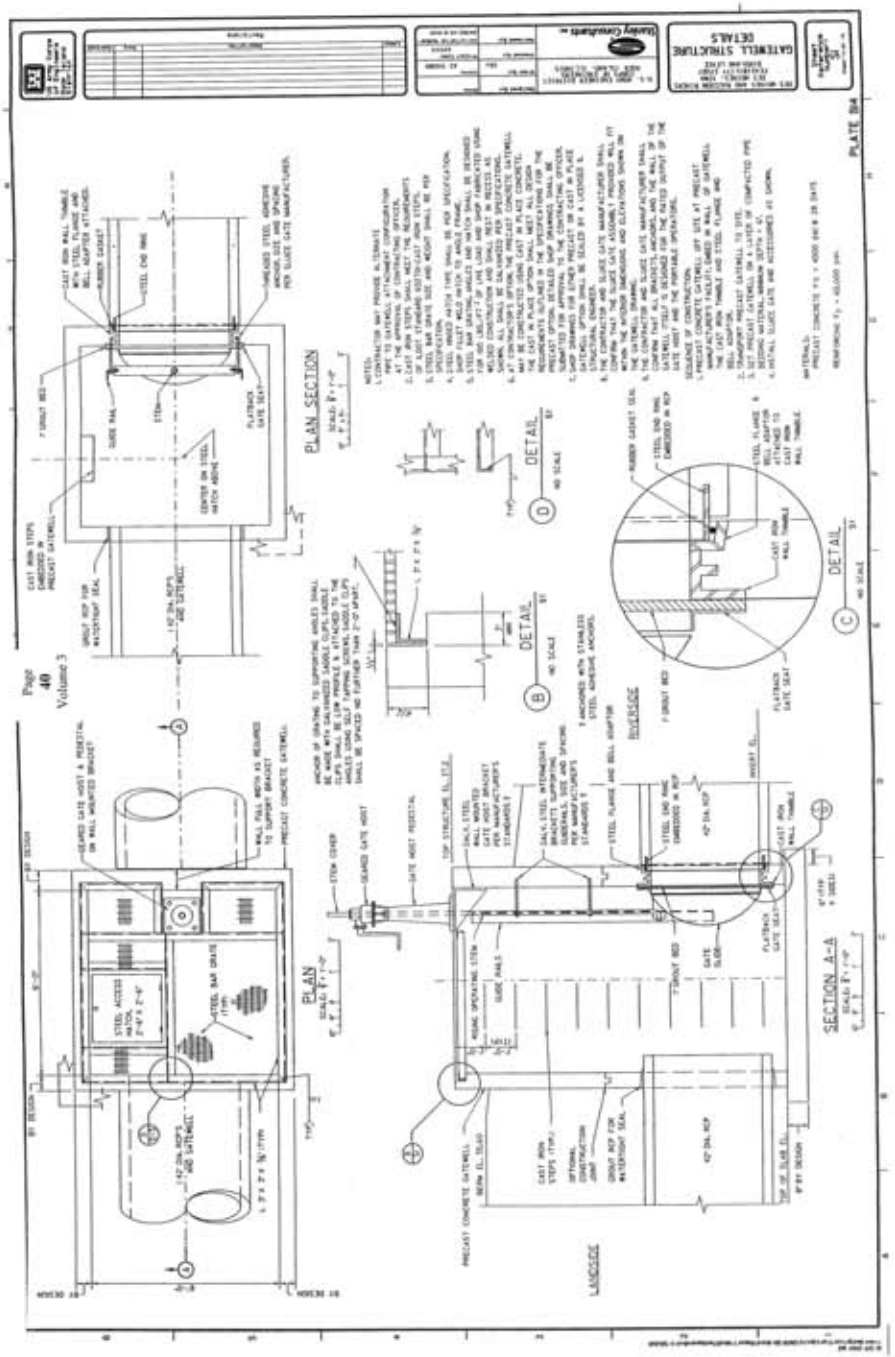
GATEWELL STRUCTURE DETAILS
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DETAIL
PLAN
SECTION A-A
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LANDSIDE
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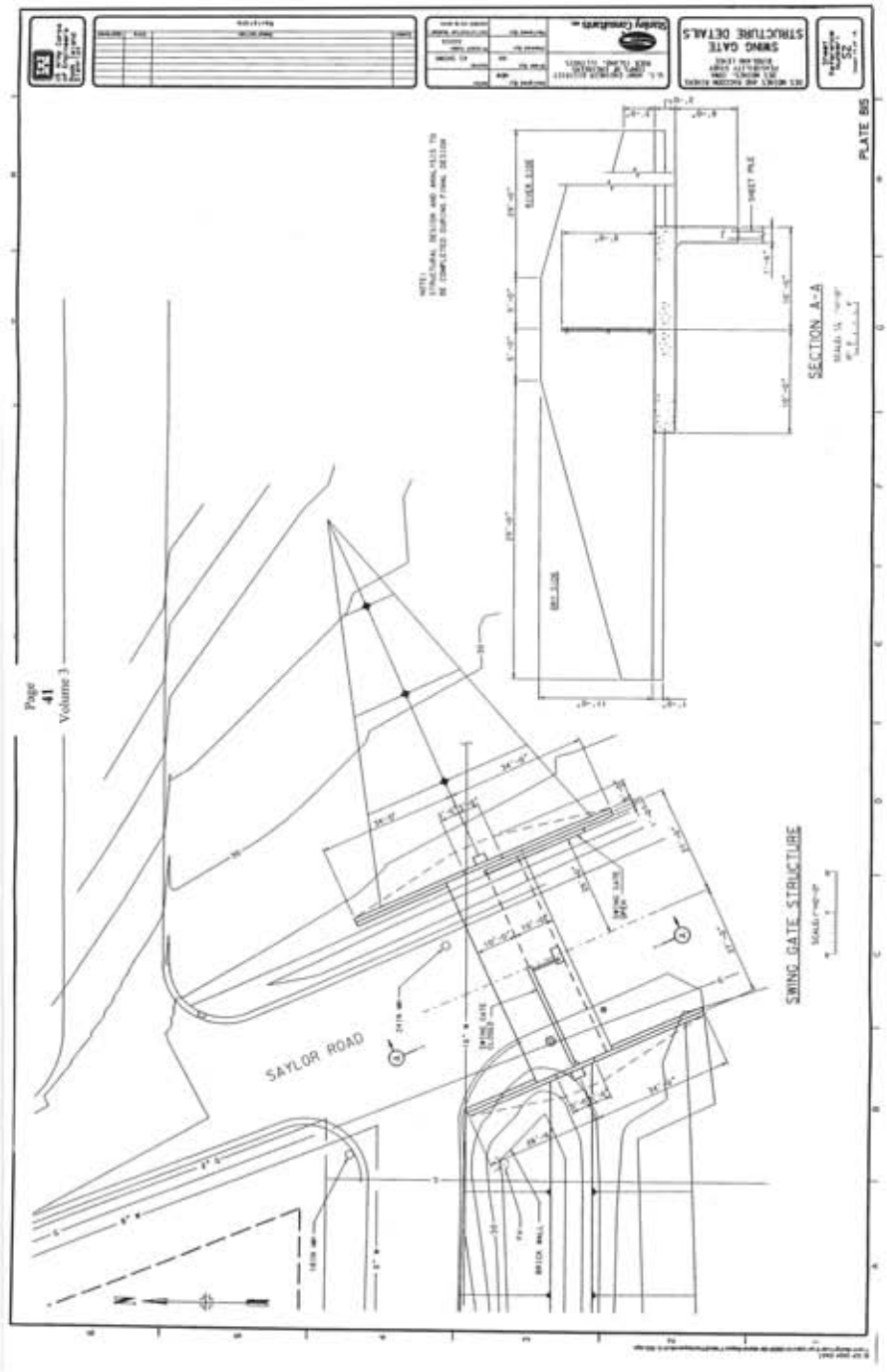
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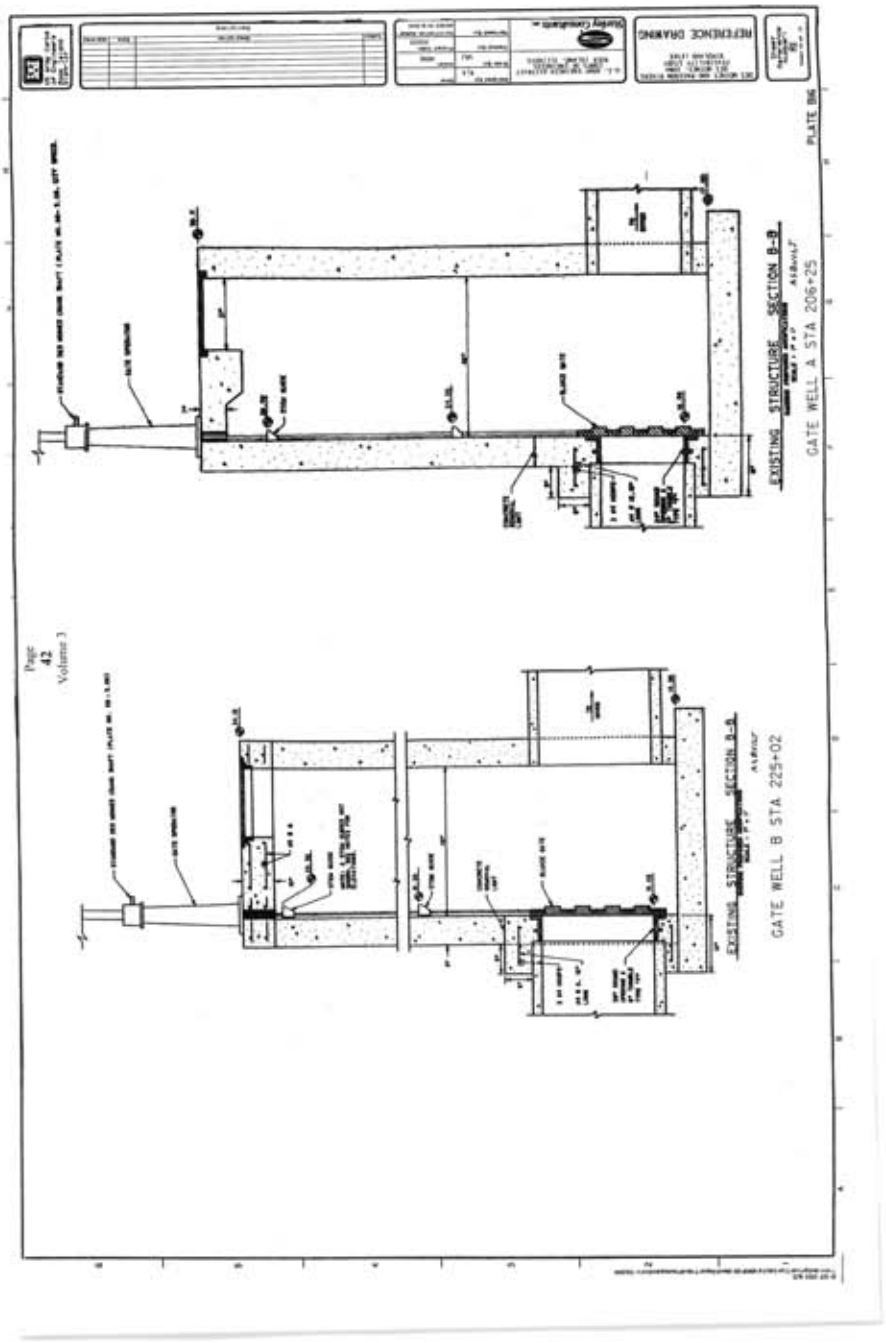
REFERENCE DRAWING
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GATE WELL A STA 206+25
EXISTING STRUCTURE SECTION B-B
GATE WELL B STA 225+02
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RIVERS, DES MOINES, IA
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COVER SHEET
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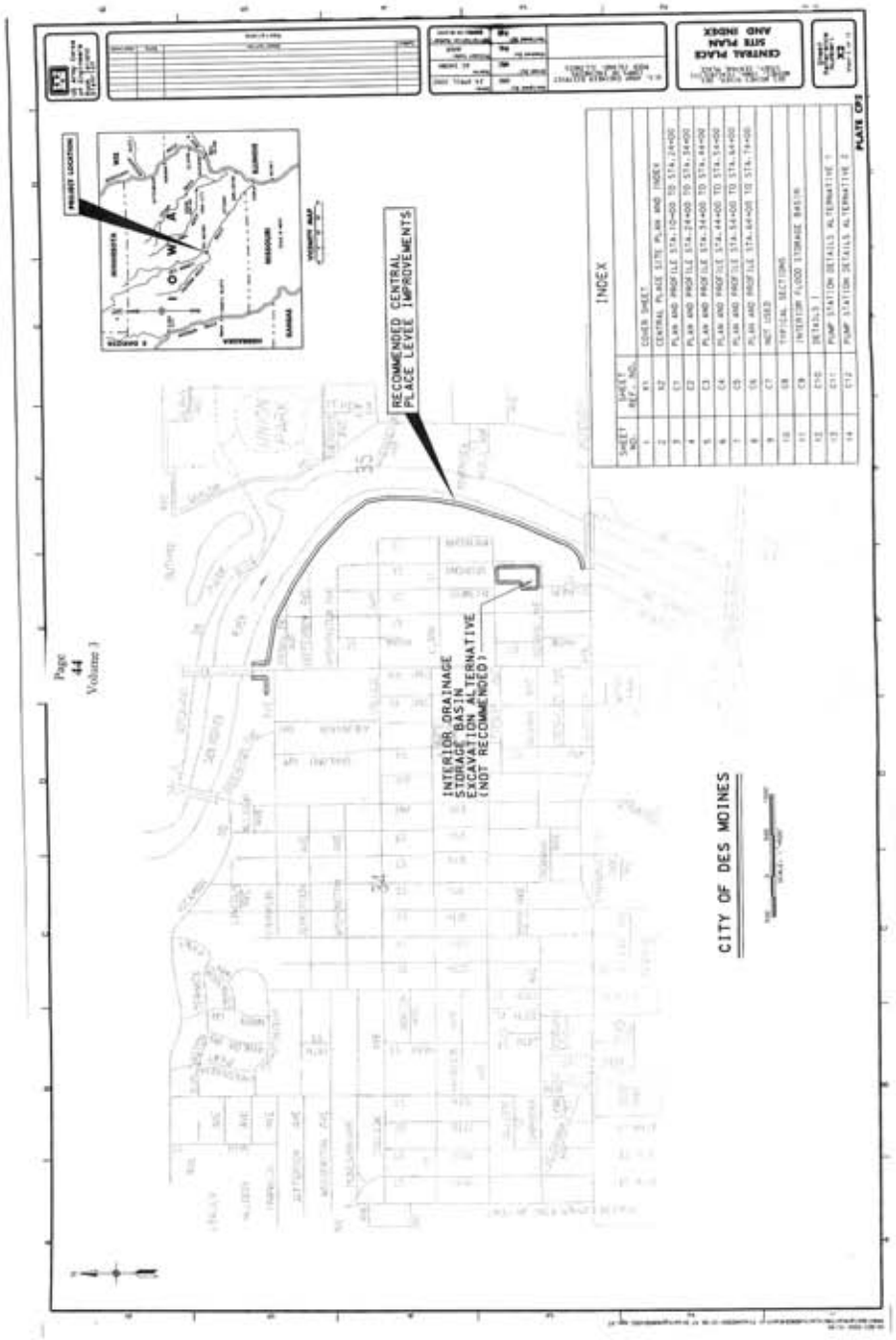
CENTRAL PLACE
SITE PLAN
AND INDEX
PLATE OF
INDEX
SHEET NO.
SHEET REF. NO.
COVER SHEET
CENTRAL PLACE SITE PLAN AND INDEX
PLAN AND PROFILE STA.10+00 TO STA.24+00
PLAN AND PROFILE STA.24+00 TO STA.34+00
PLAN AND PROFILE STA.34+00 TO STA.44+00
PLAN AND PROFILE STA.44+00 TO STA.54+00
PLAN AND PROFILE STA.54+00 TO STA.64+00
PLAN AND PROFILE STA.64+00 TO STA.74+00
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TYPICAL SECTIONS
INTERIOR FLOOD STORAGE BASIN
DETAILS 1
PUMP STATION DETAILS ALTERNATIVE 1
PUMP STATION DETAILS ALTERNATIVE 2
PROJECT LOCATION
VICINITY MAP
RECOMMENDED CENTRAL PLACE LEVEE IMPROVEMENTS
INTERIOR DRAINAGE STORAGE BASIN EXCAVATION ALTERNATIVE (NOT RECOMMENDED)
CITY OF DES MOINES
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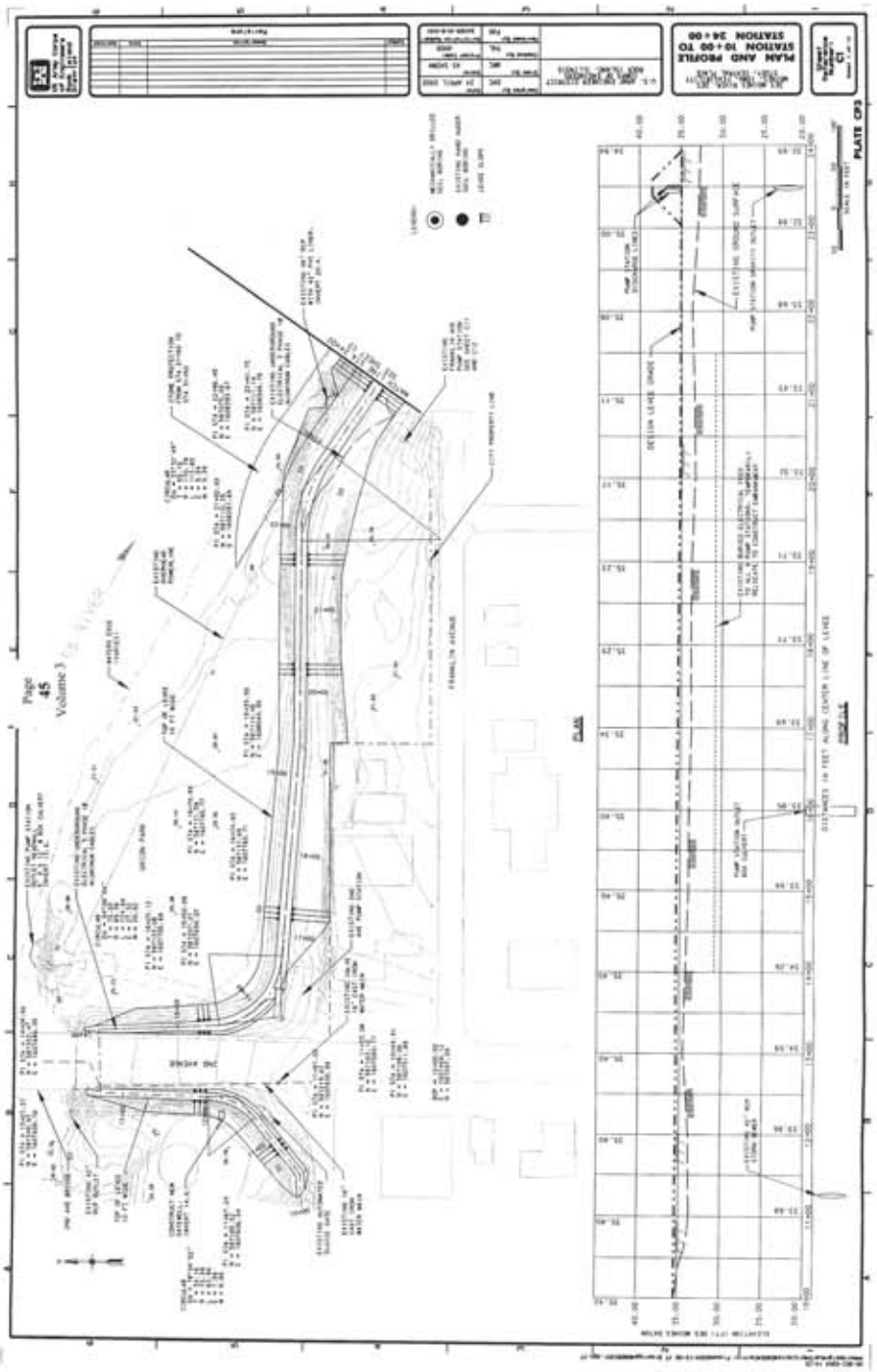
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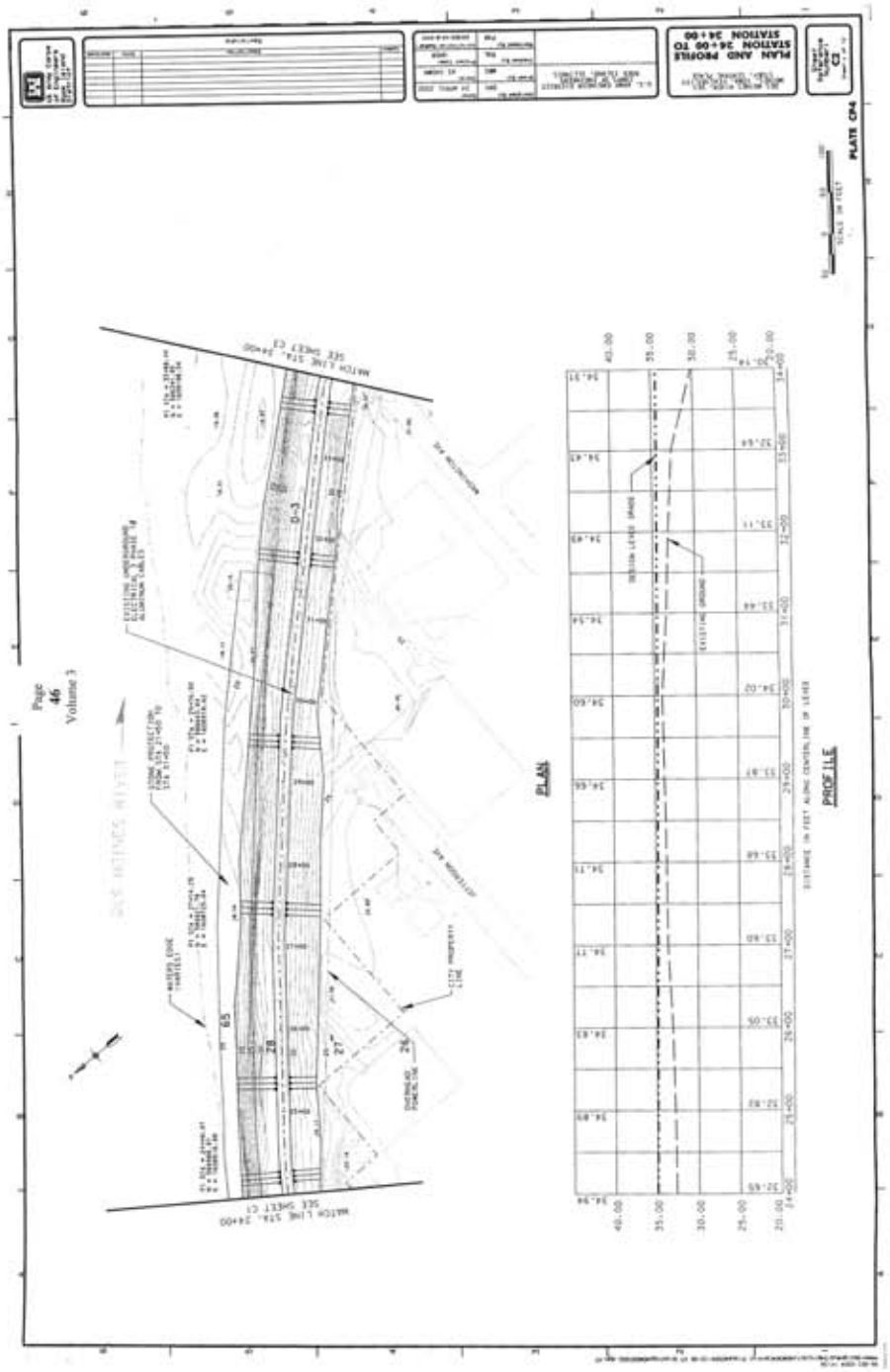
PLAN AND PROFILE
STATION 10+00 TO
STATION 34+00
PLATE CP3
PLAN
PROFILE
FRANKLIN AVENUE
2ND AVENUE
DESIGN LEVEE GRADE
EXISTING GROUND SURFACE
DISTANCES IN FEET ALONG CENTER LINE OF LEVEE


PLAN AND PROFILE
STATION 24+00 TO
STATION 34+00
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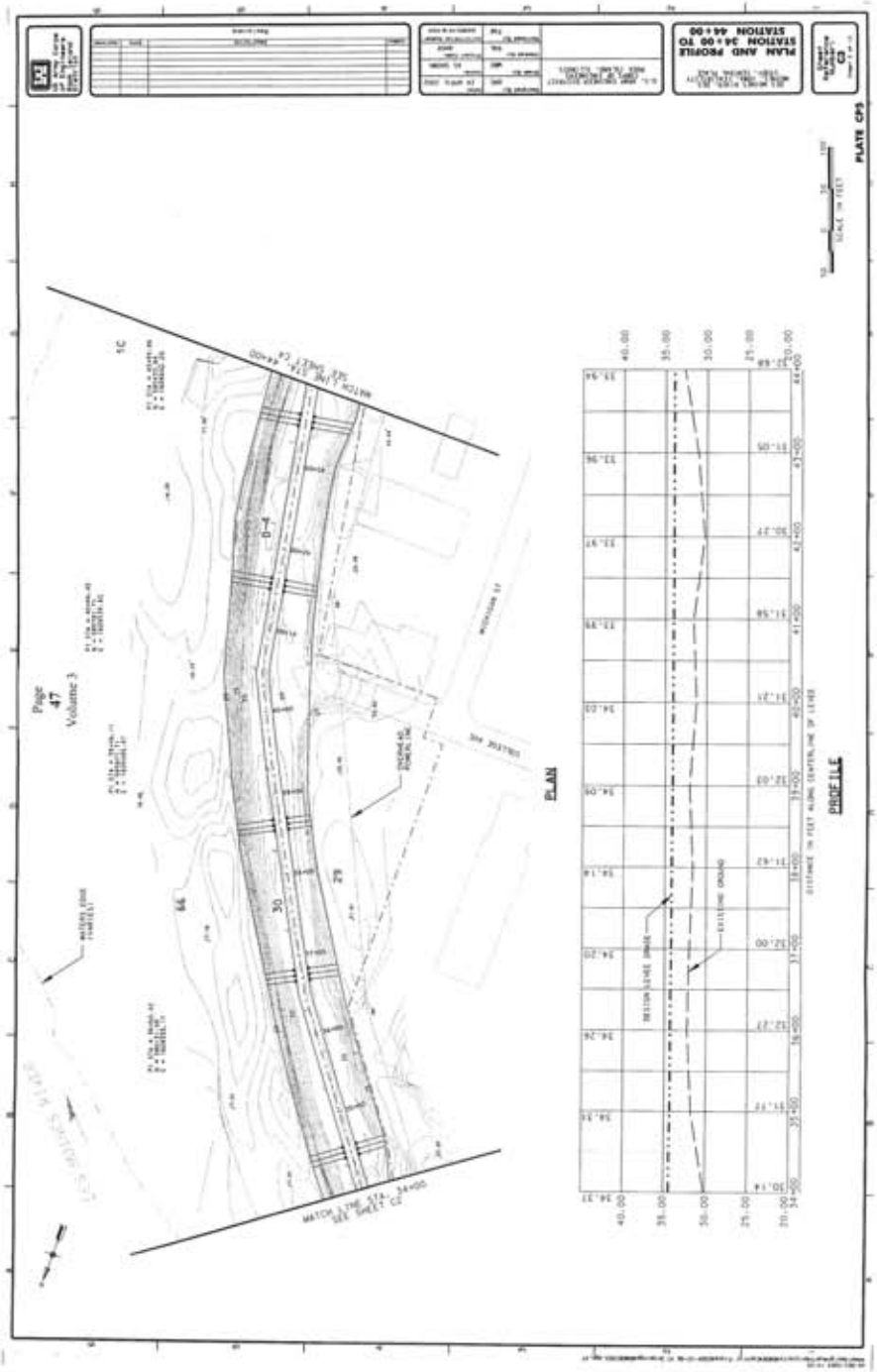
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STATION 34+00 TO
STATION 44+00
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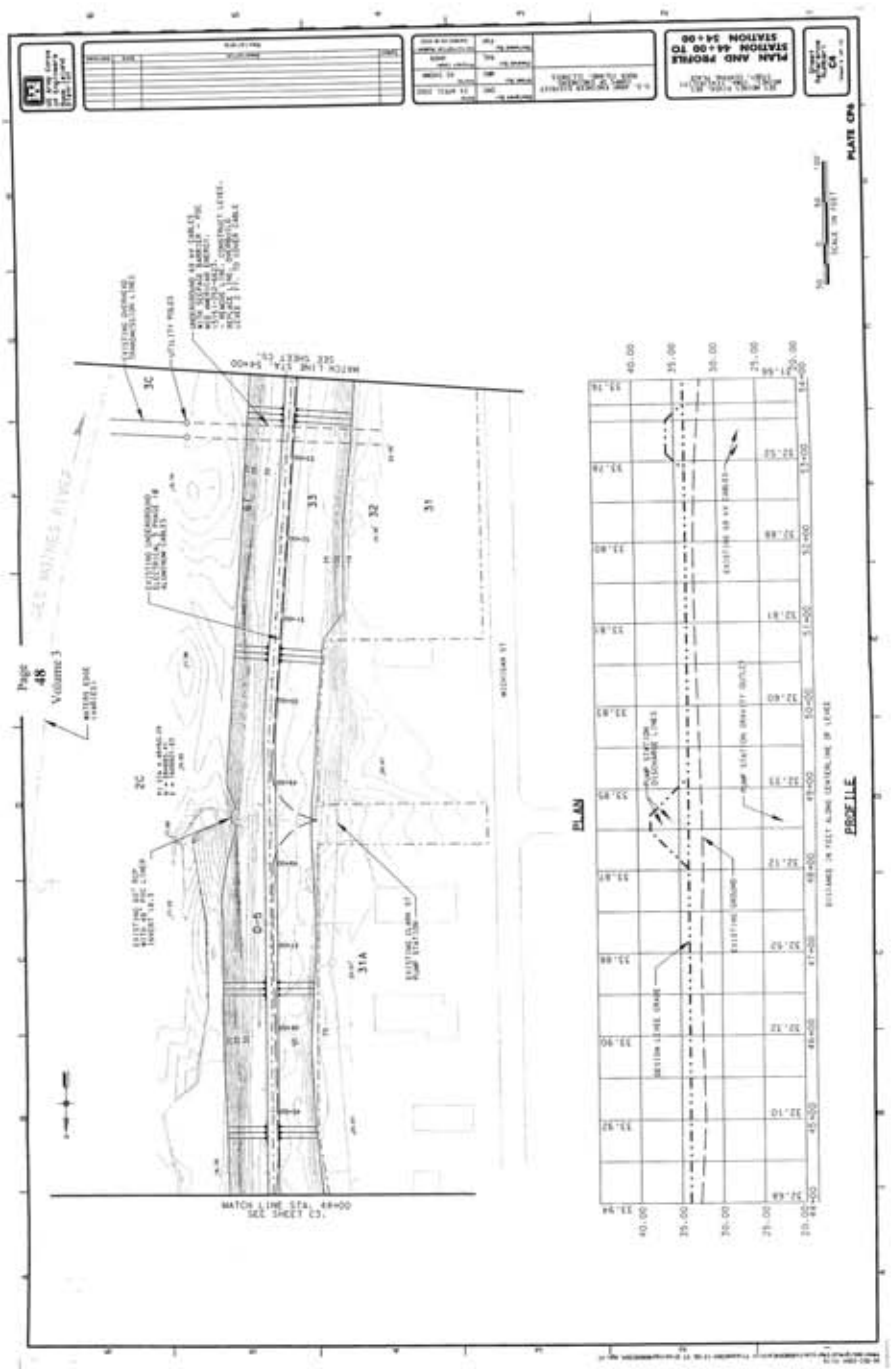
PROFILE
MATCH LINE STA. 34+00
SEE SHEET C2
MATCH LINE STA. 44+00
SEE SHEET C4
DISTANCE IN FEET ALONG CENTERLINE OF LEVEE
EXISTING GROUND
DESIGN LEVEE GRADE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STATION 44+00 TO
STATION 54+00
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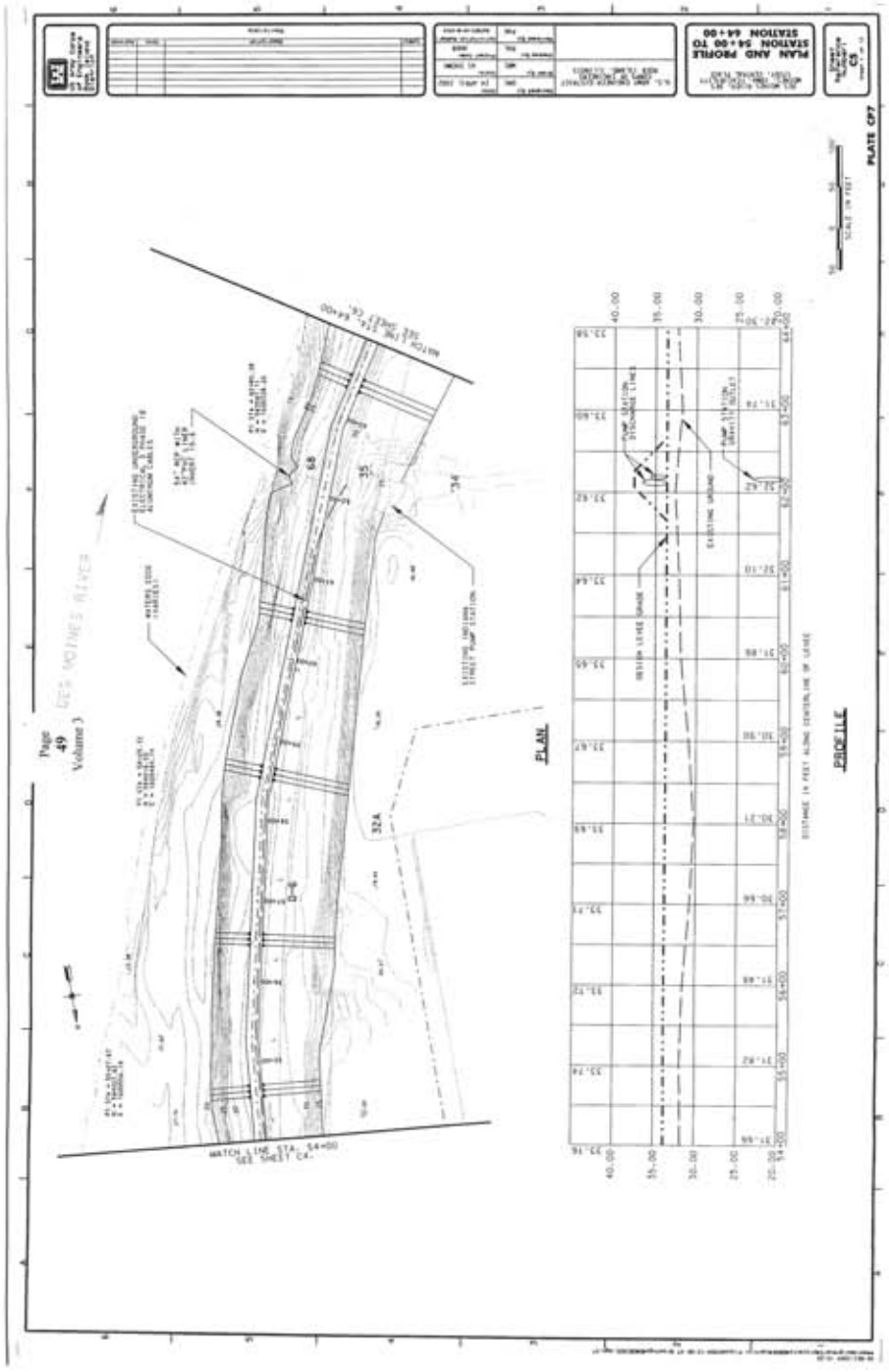
MATCH LINE STA. 54+00
SEE SHEET C3.
MATCH LINE STA. 48+00
SEE SHEET C3.
PLAN
PROFILE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STATION 54+00 TO
STATION 64+00
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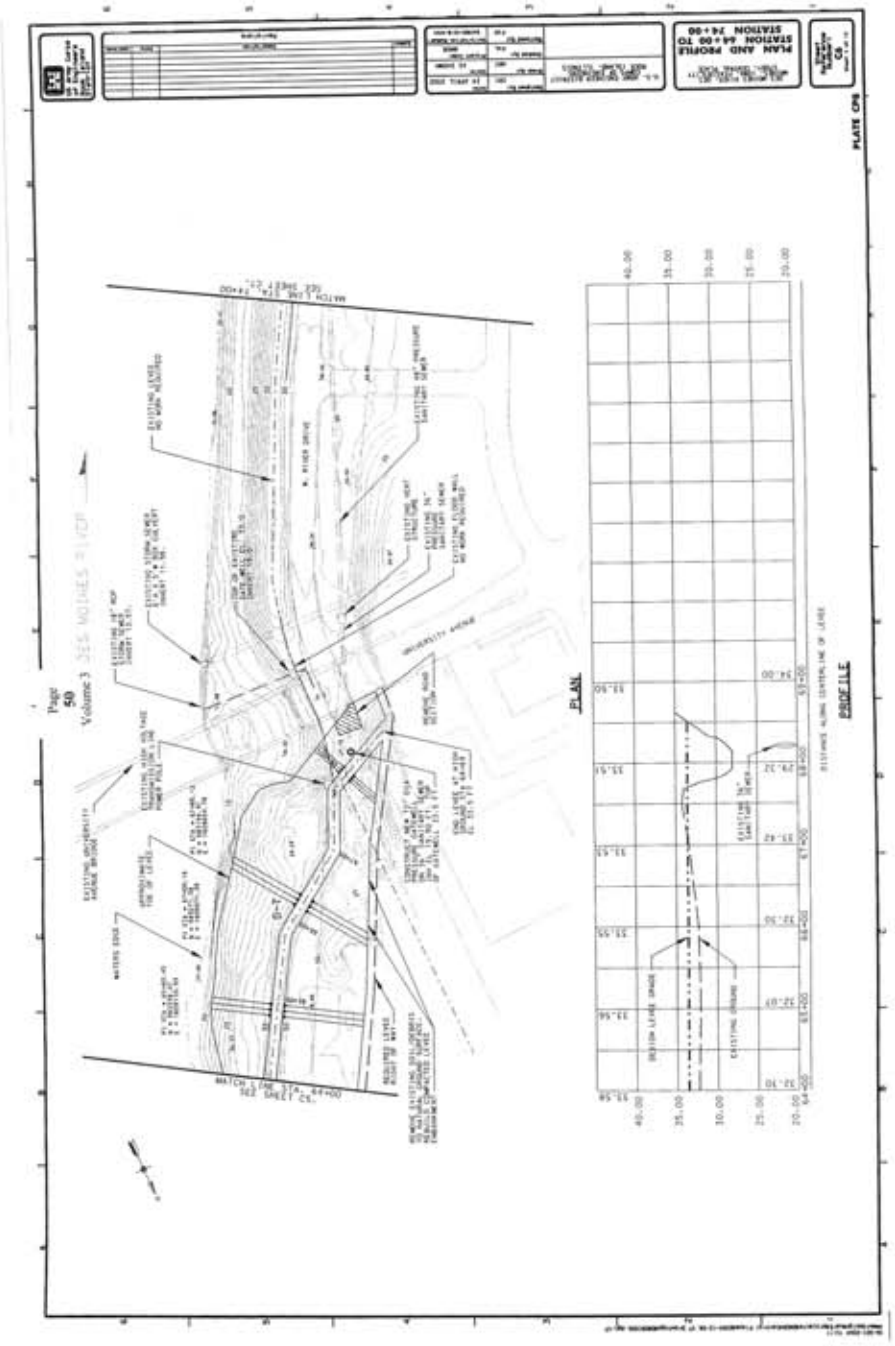
MATCH LINE STA. 64+00
SEE SHEET C6
MATCH LINE STA. 54+00
SEE SHEET C4
EXISTING GROUND
DESIGN LEVEE GRADE
DISTANCE IN FEET ALONG CENTERLINE OF LEVEE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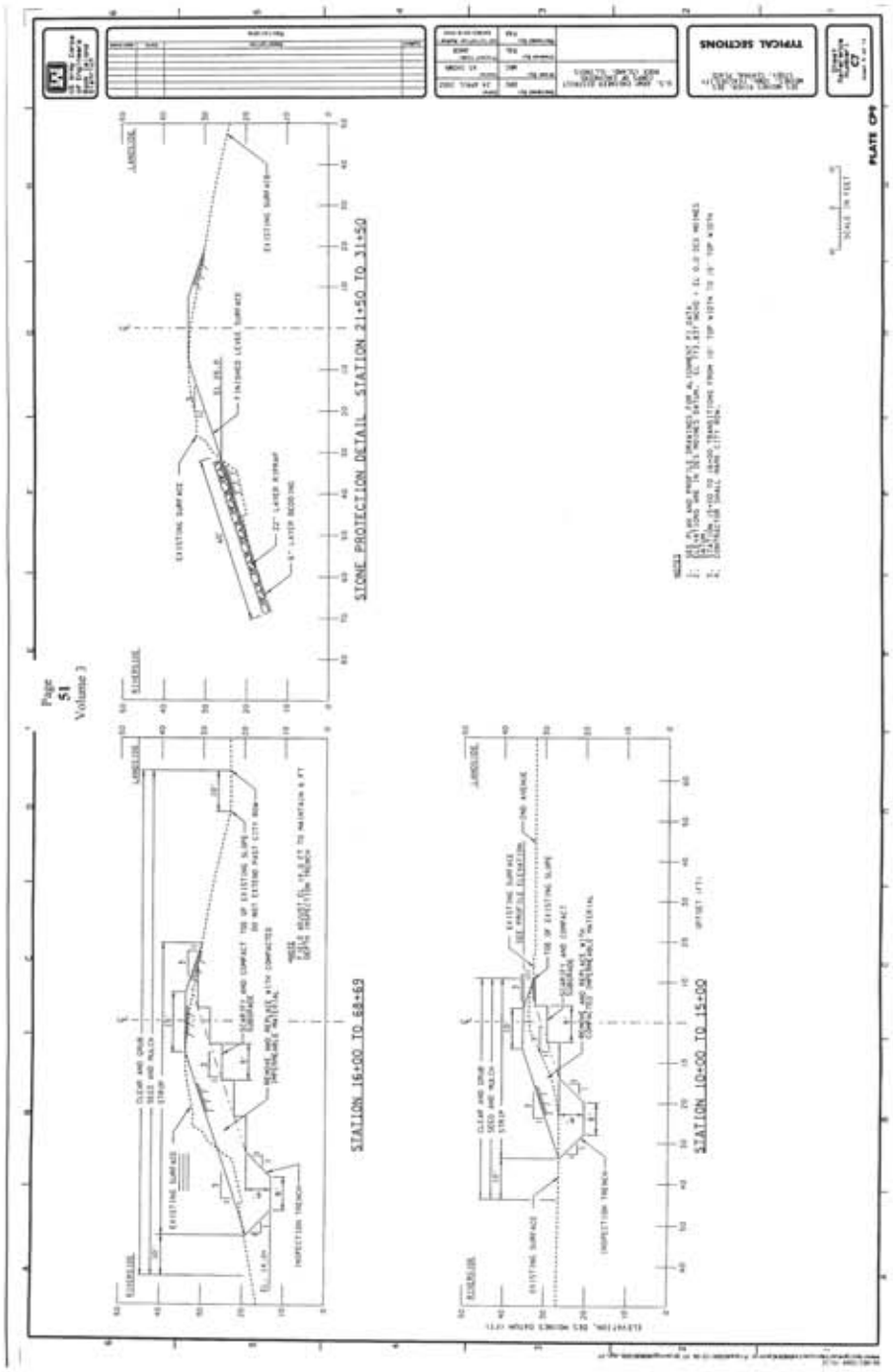
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STATION 10+00 TO 15+00
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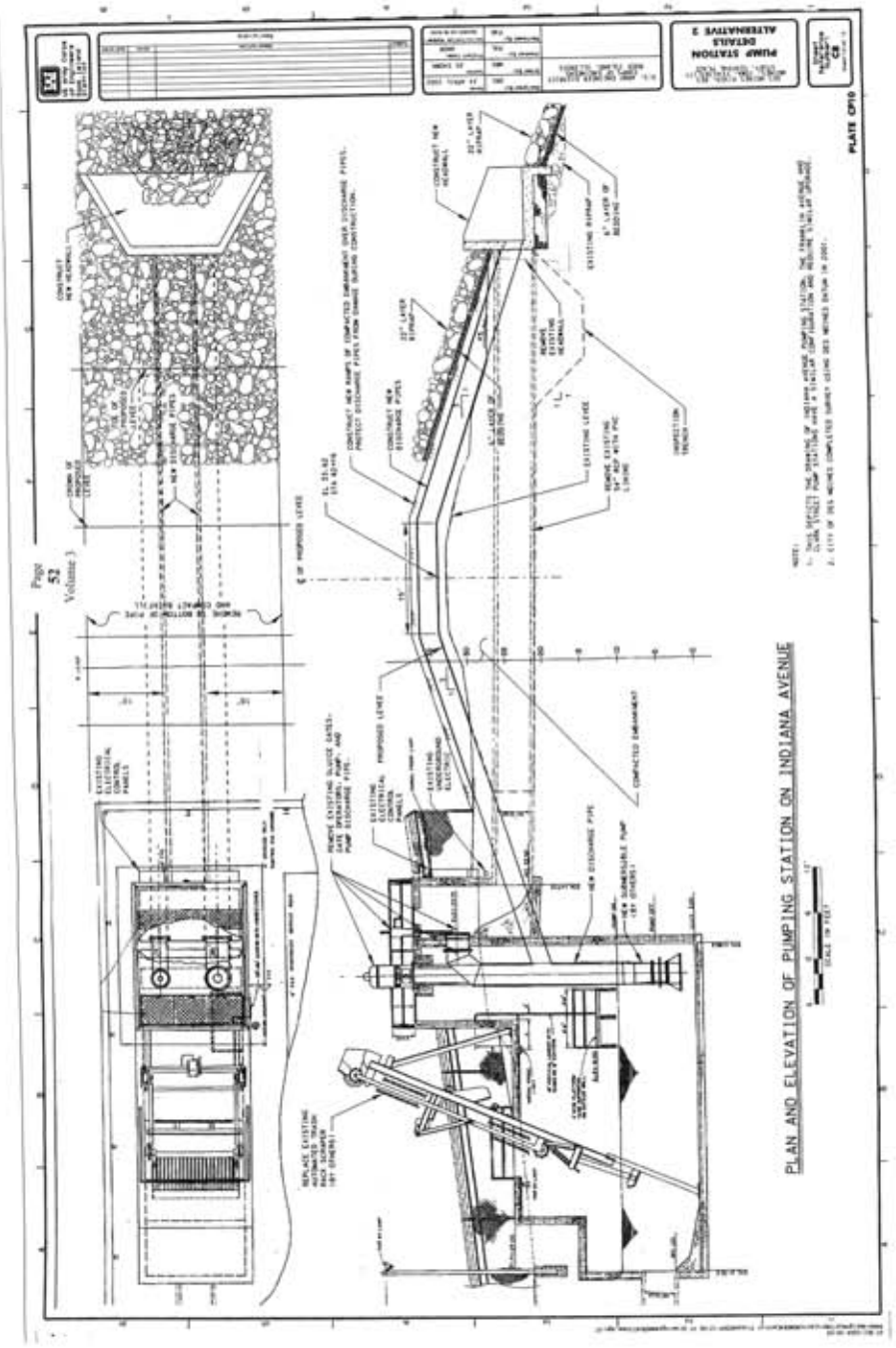
PLAN AND ELEVATION OF PUMPING STATION ON INDIANA AVENUE
PUMP STATION DETAILS ALTERNATIVE 3
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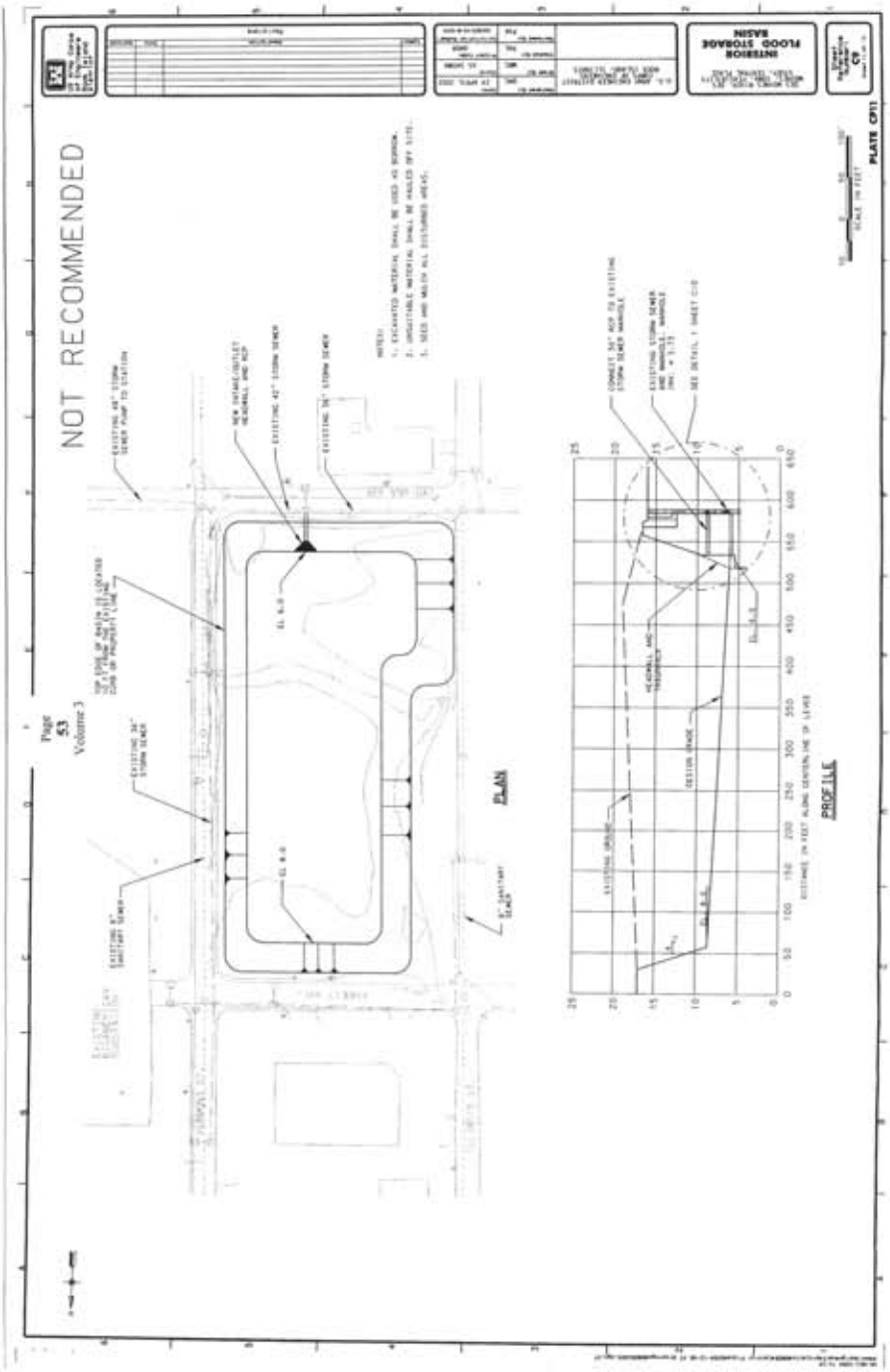
NOT RECOMMENDED
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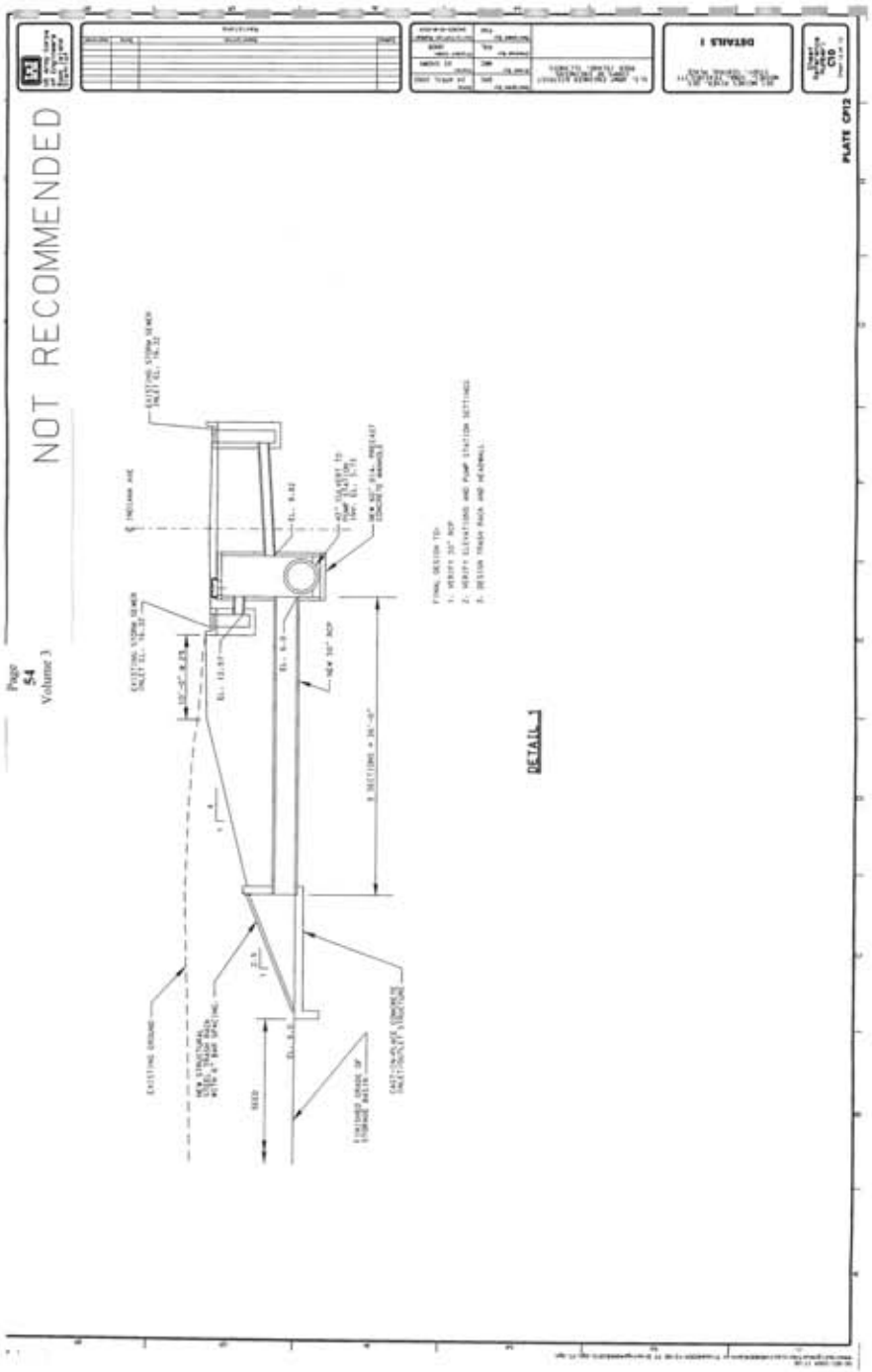
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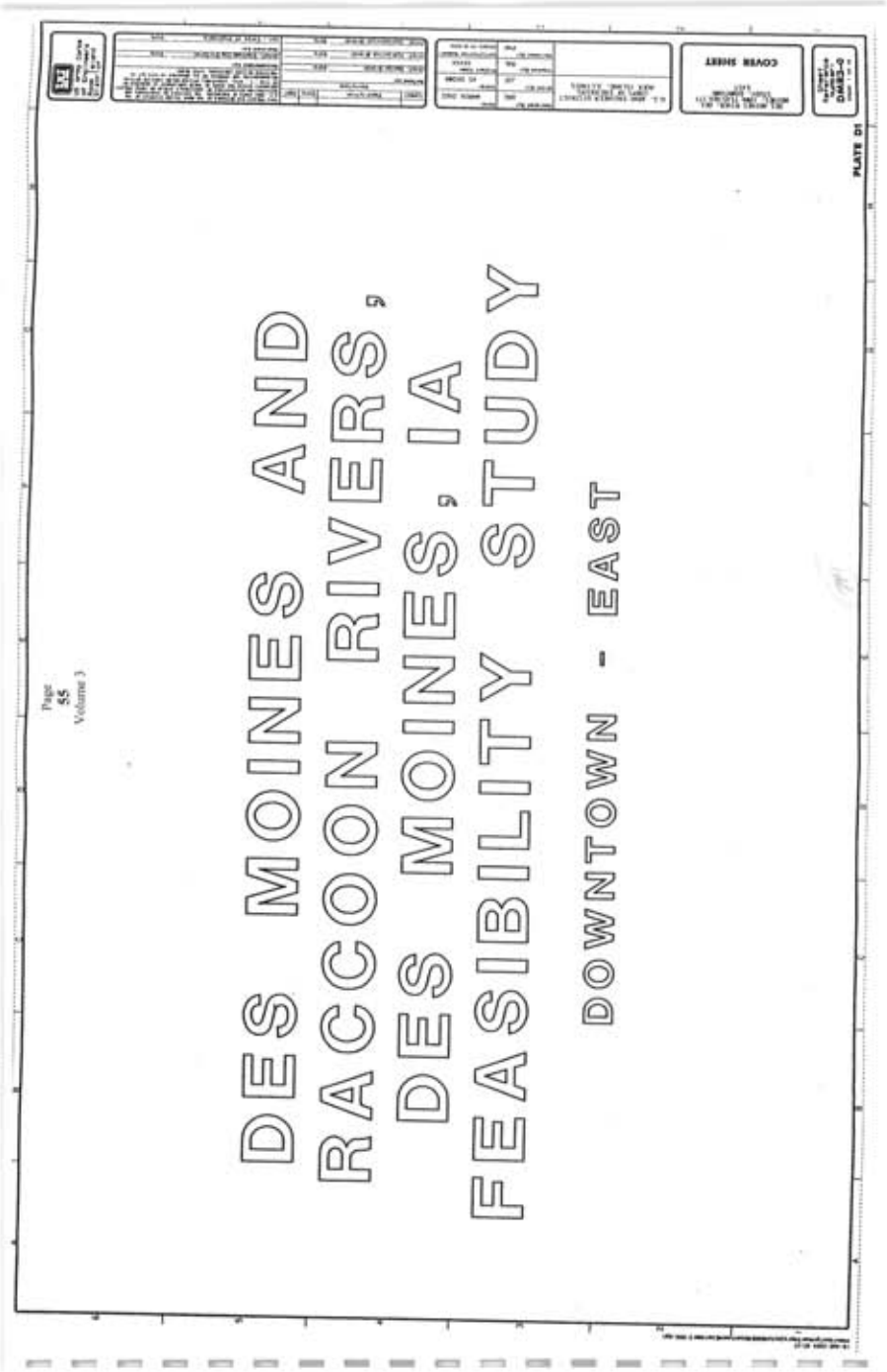
DETAIL


DES MOINES AND
RACCOON RIVERS,
DES MOINES, IA
FEASIBILITY STUDY
DOWNTOWN - EAST
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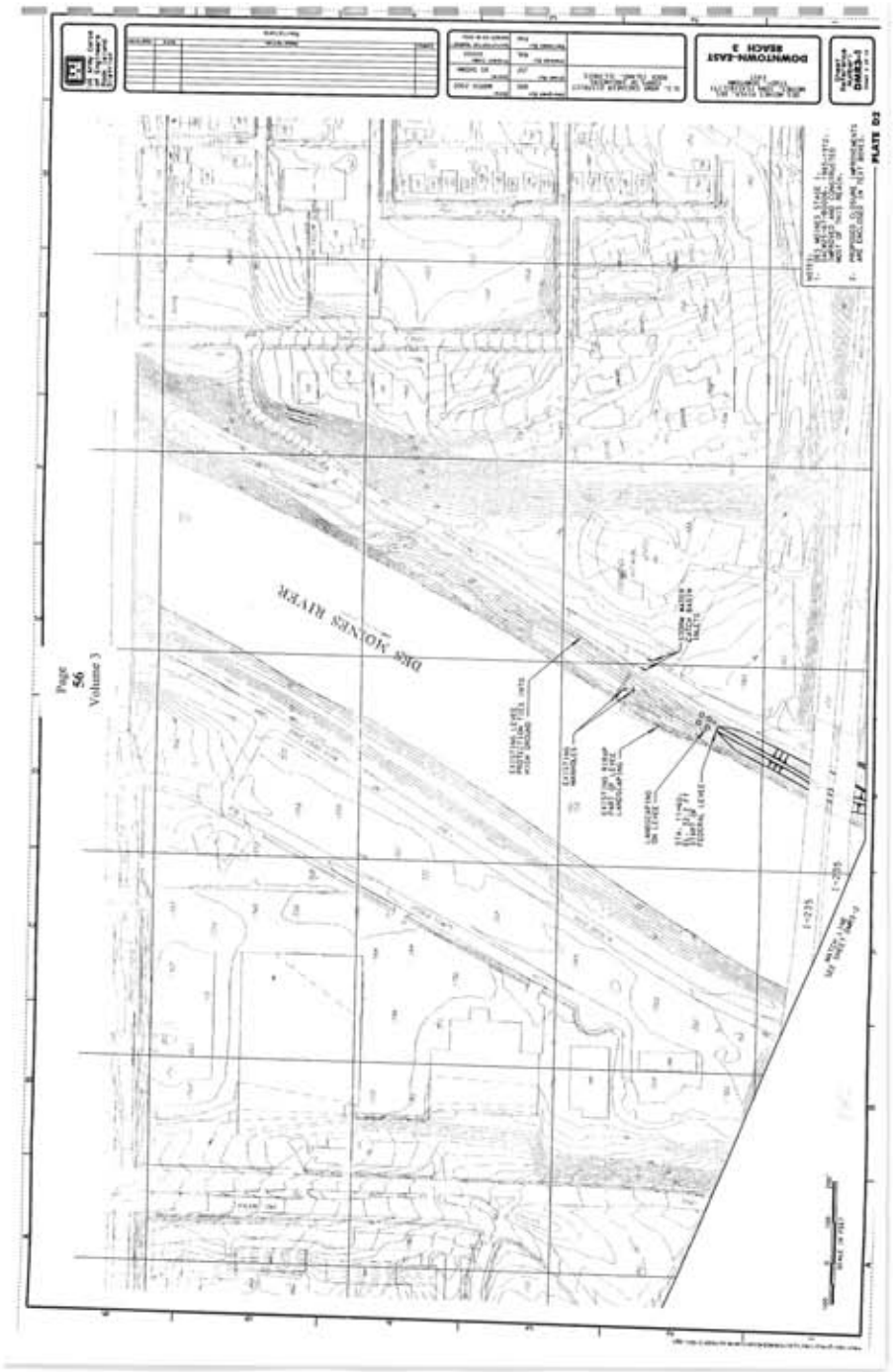
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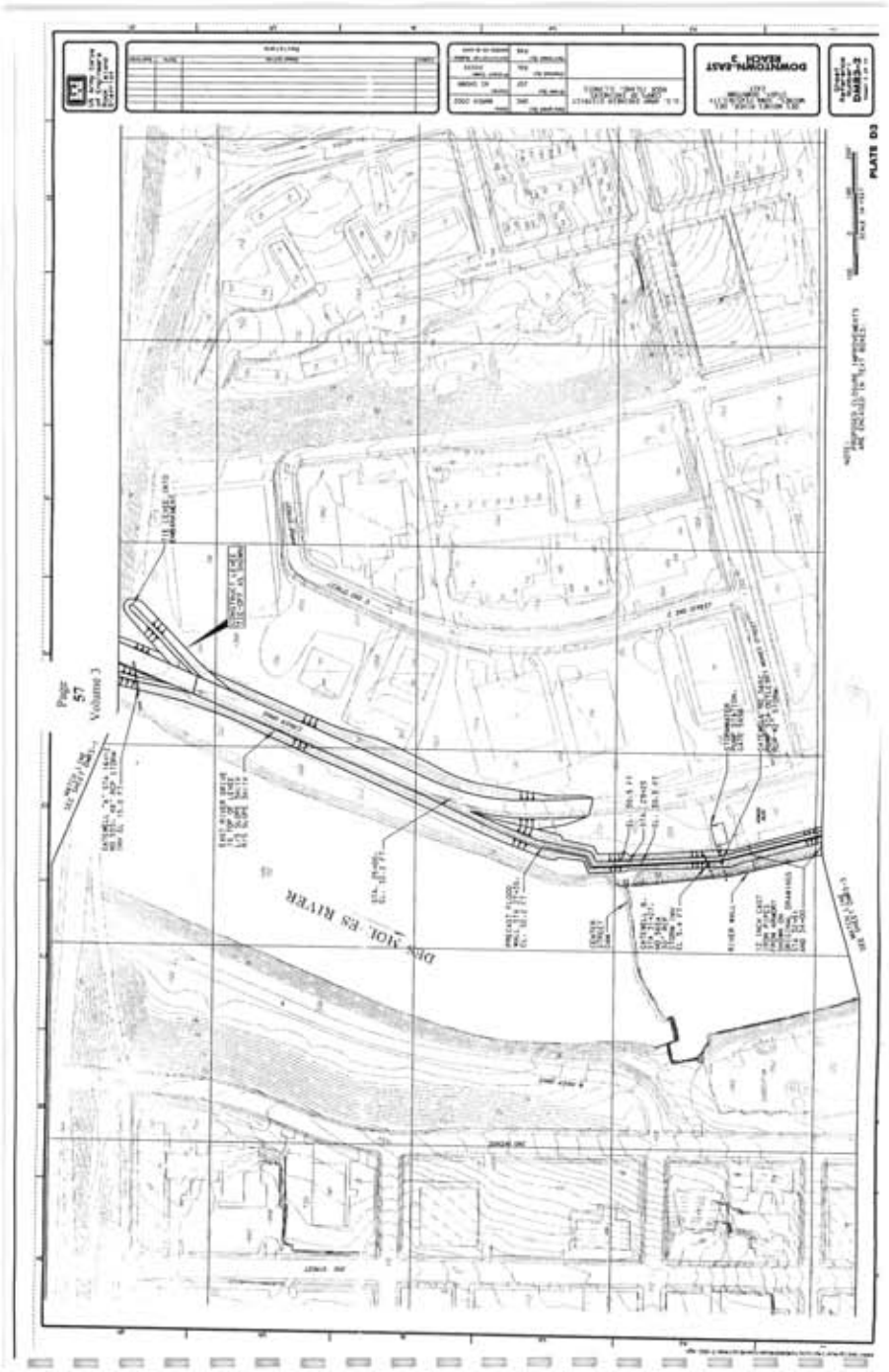
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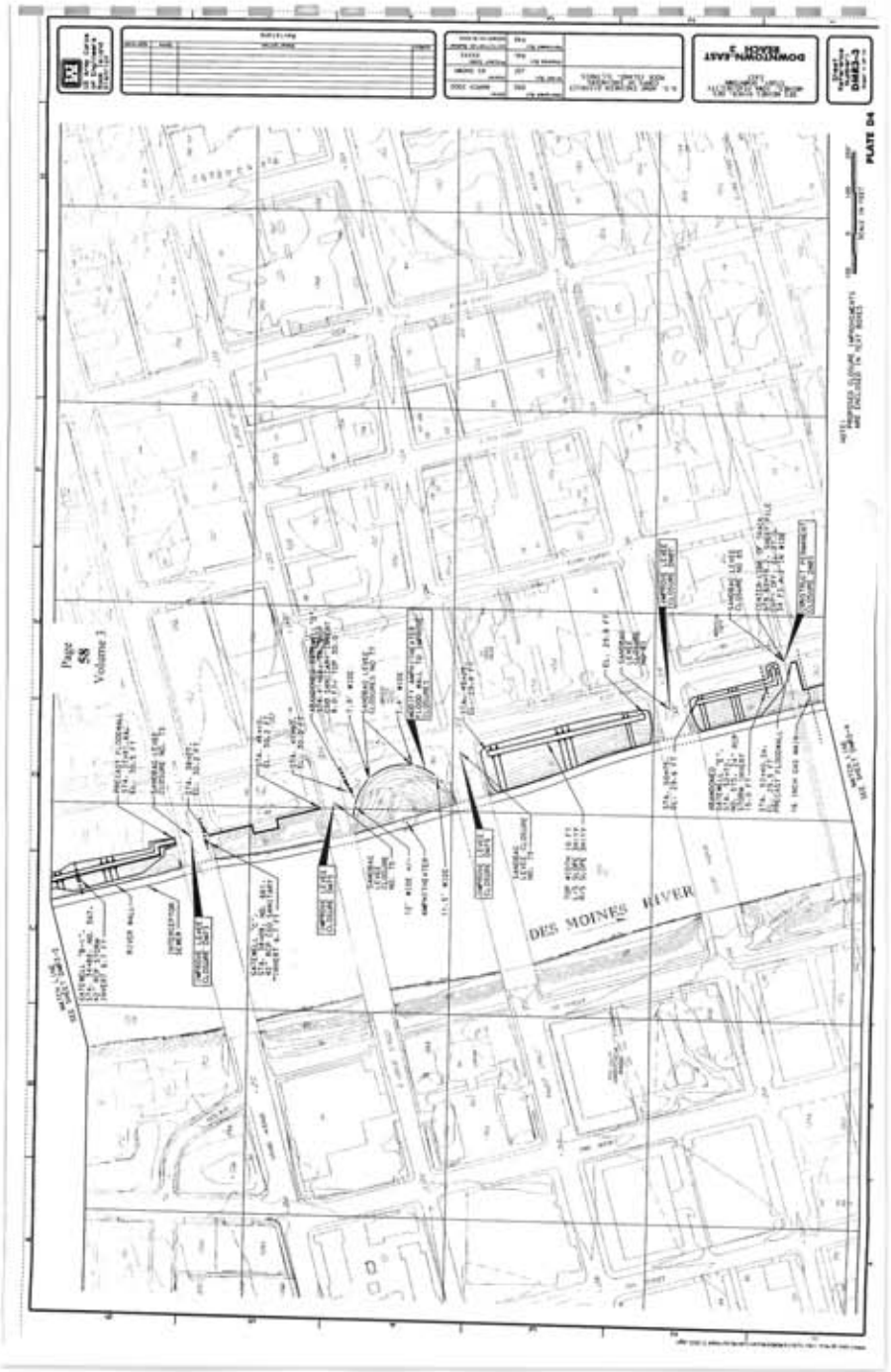
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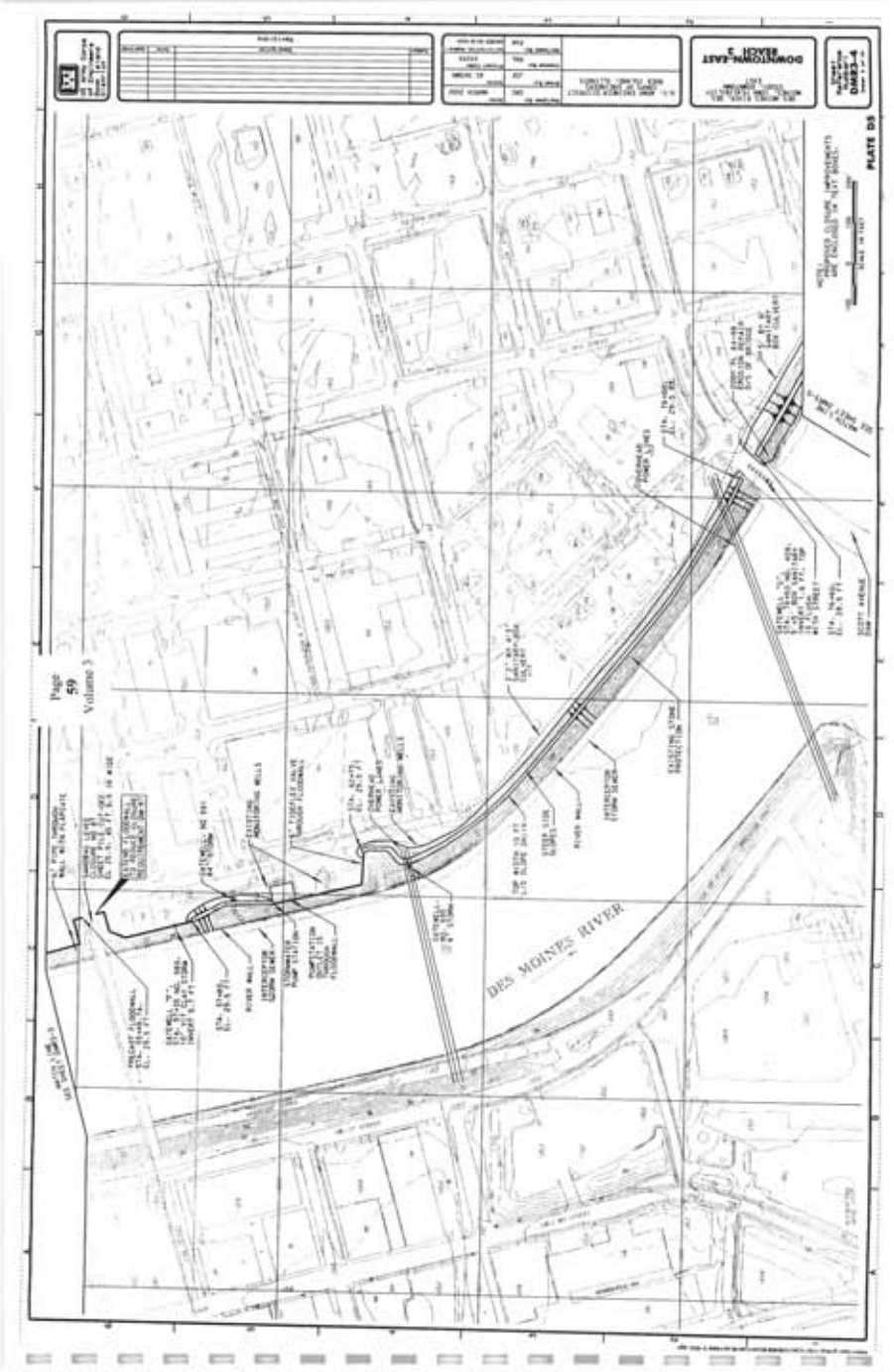
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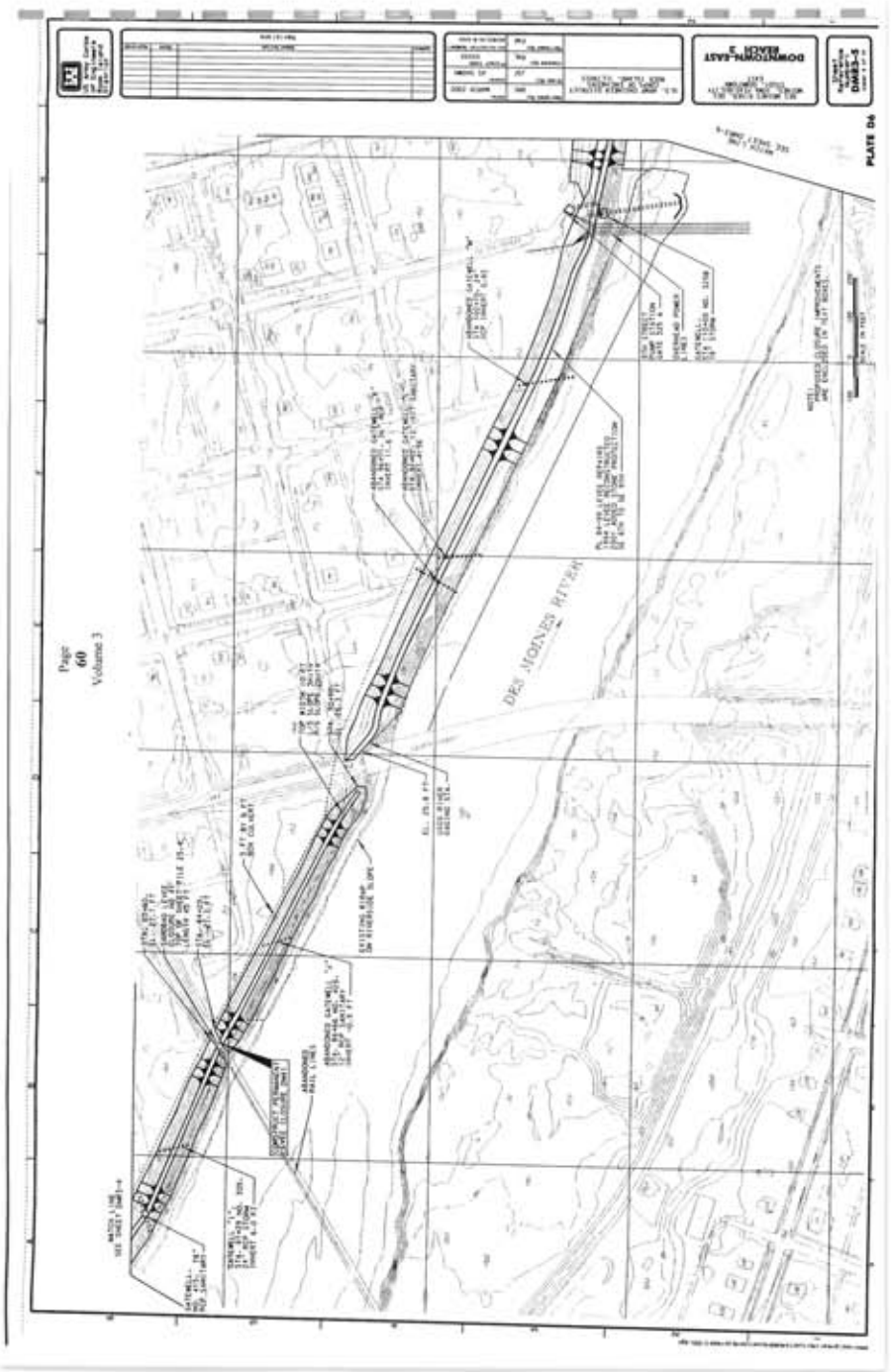
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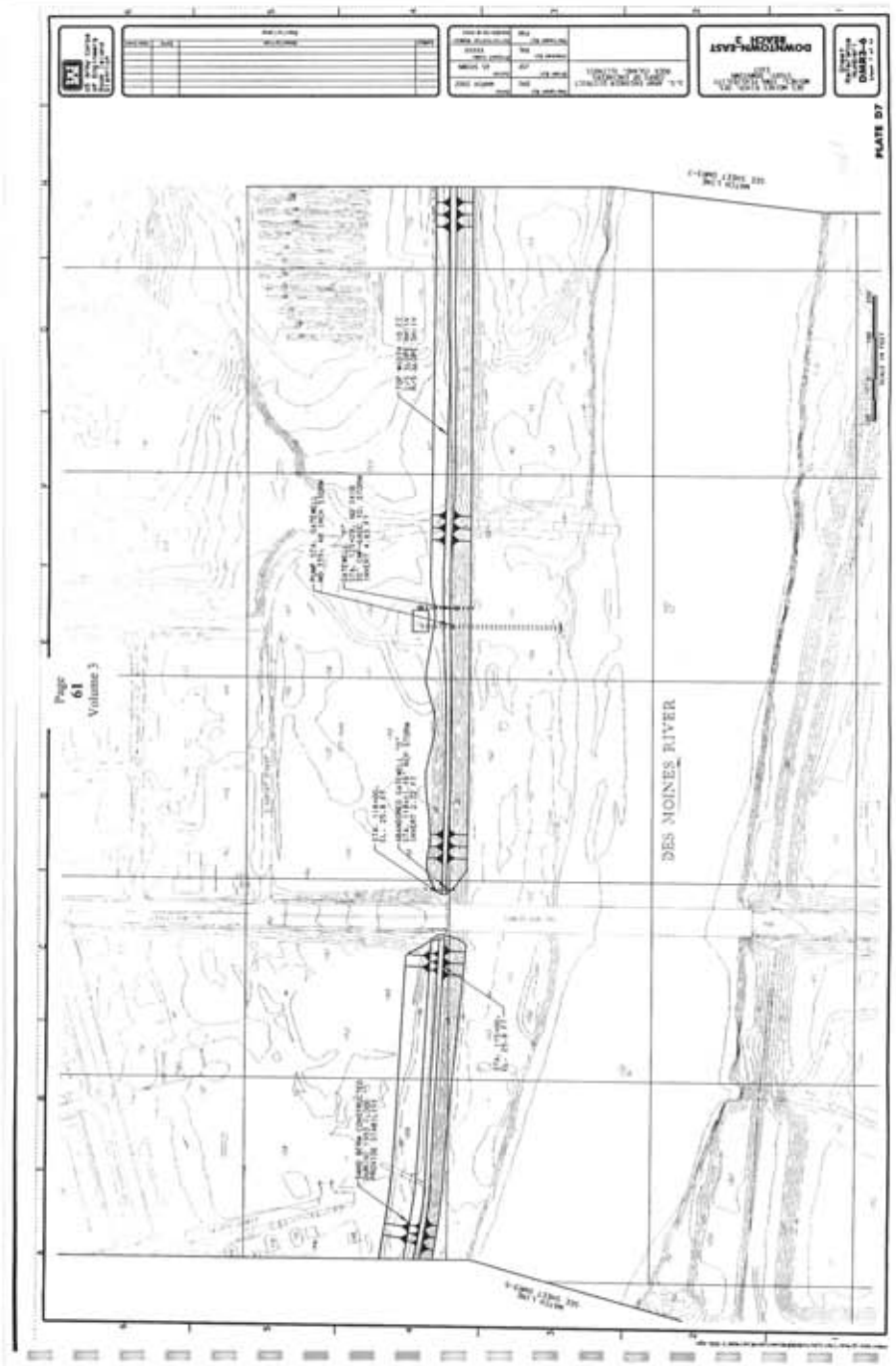
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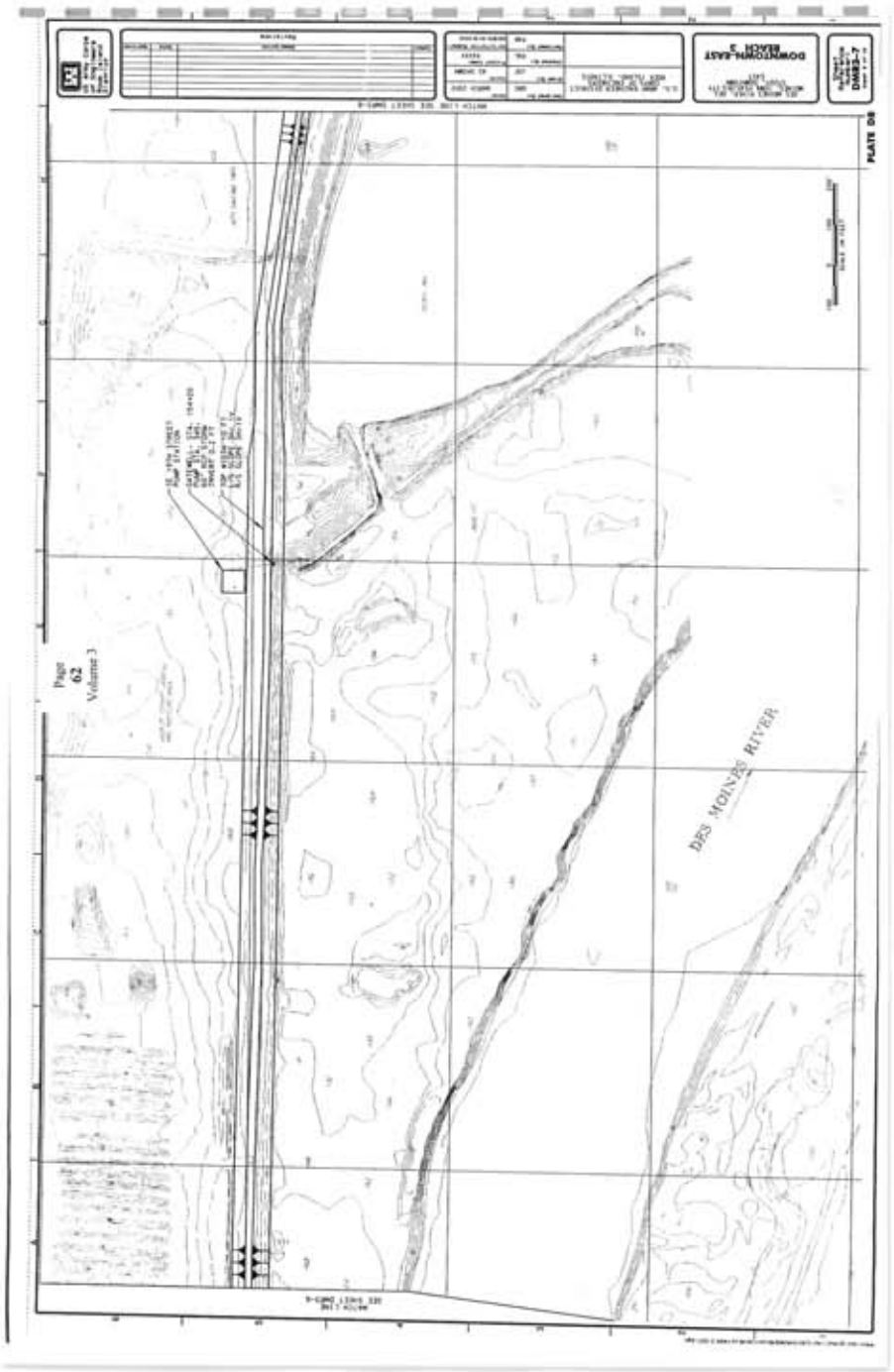
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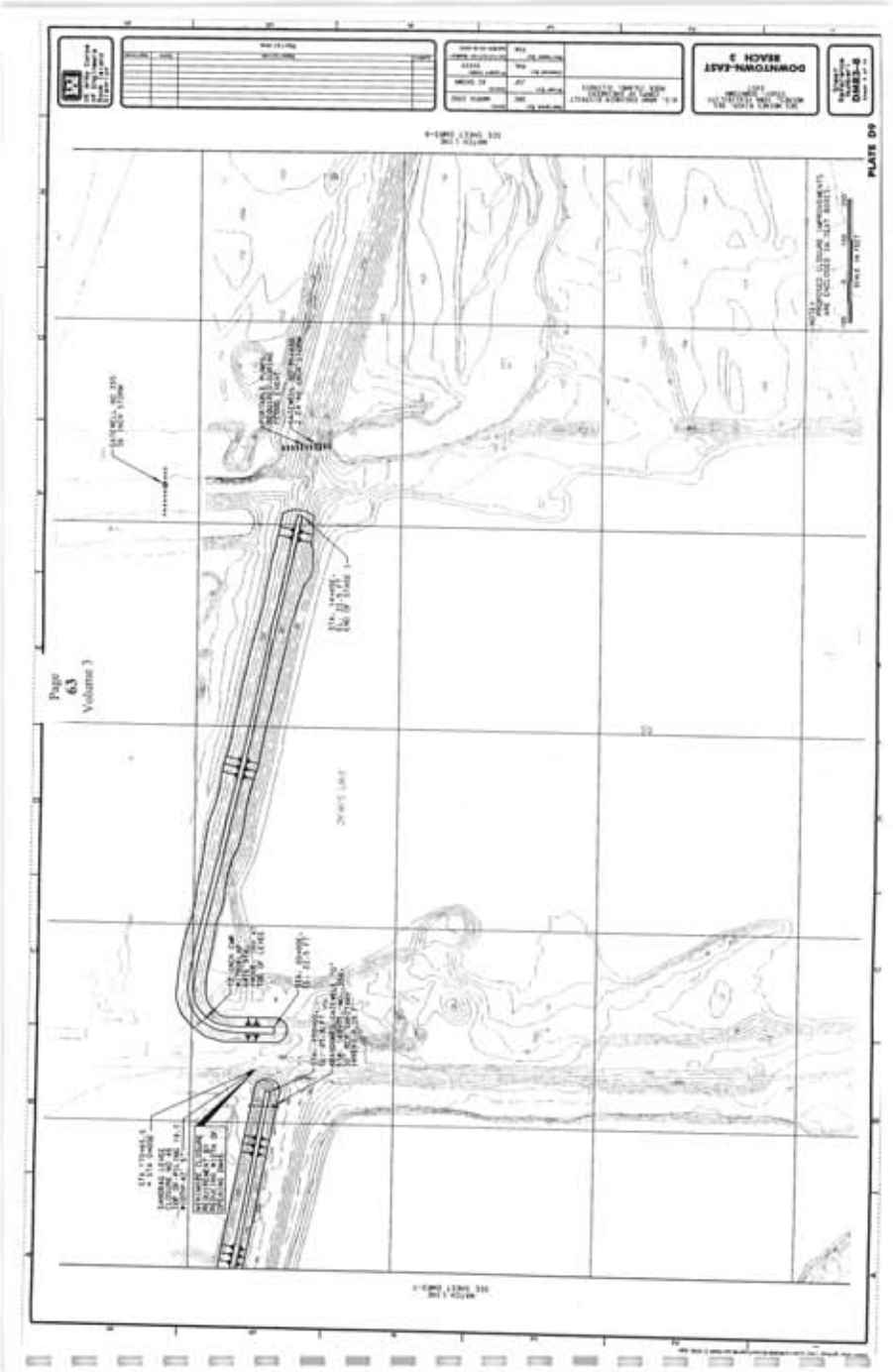
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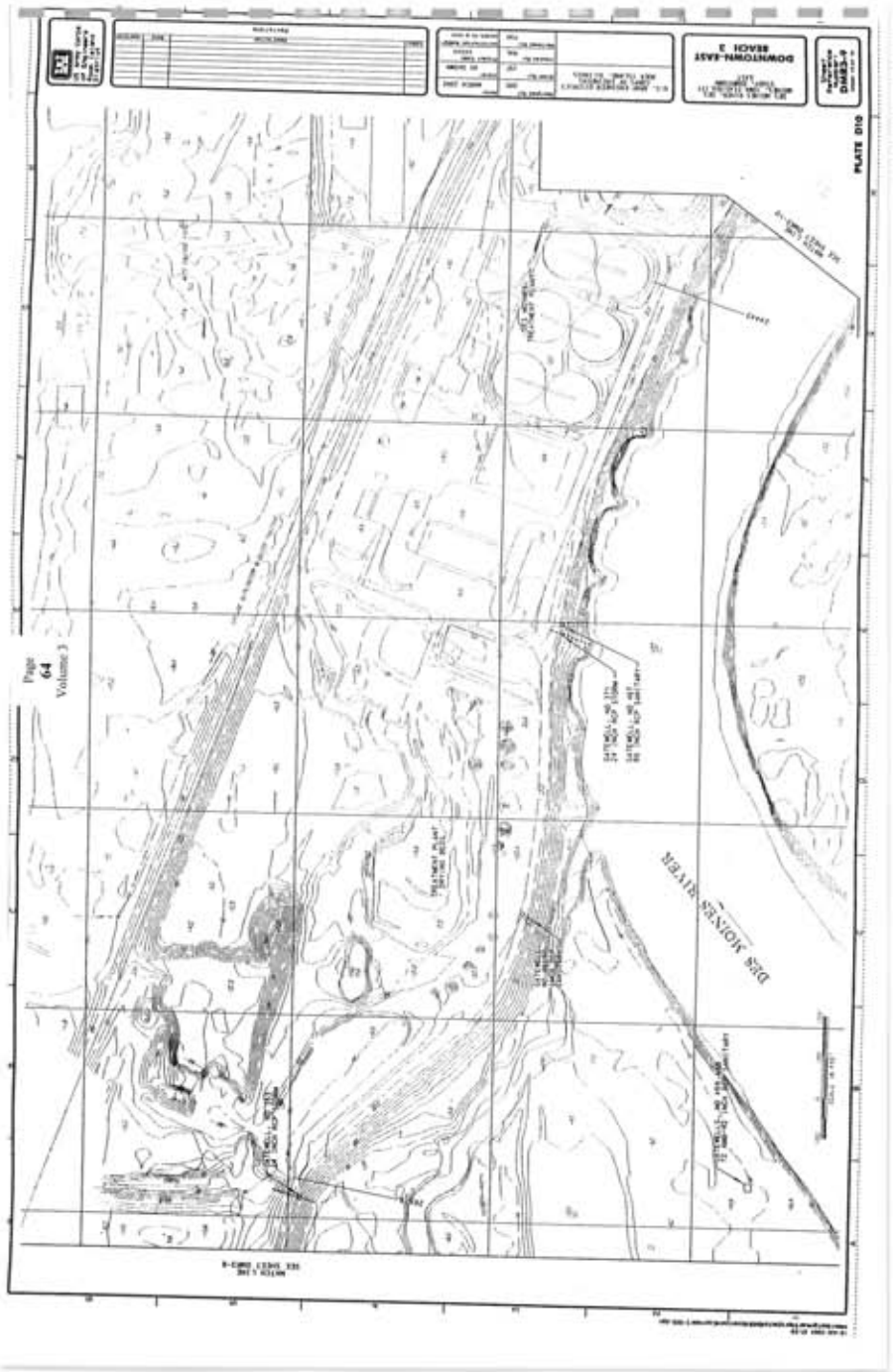
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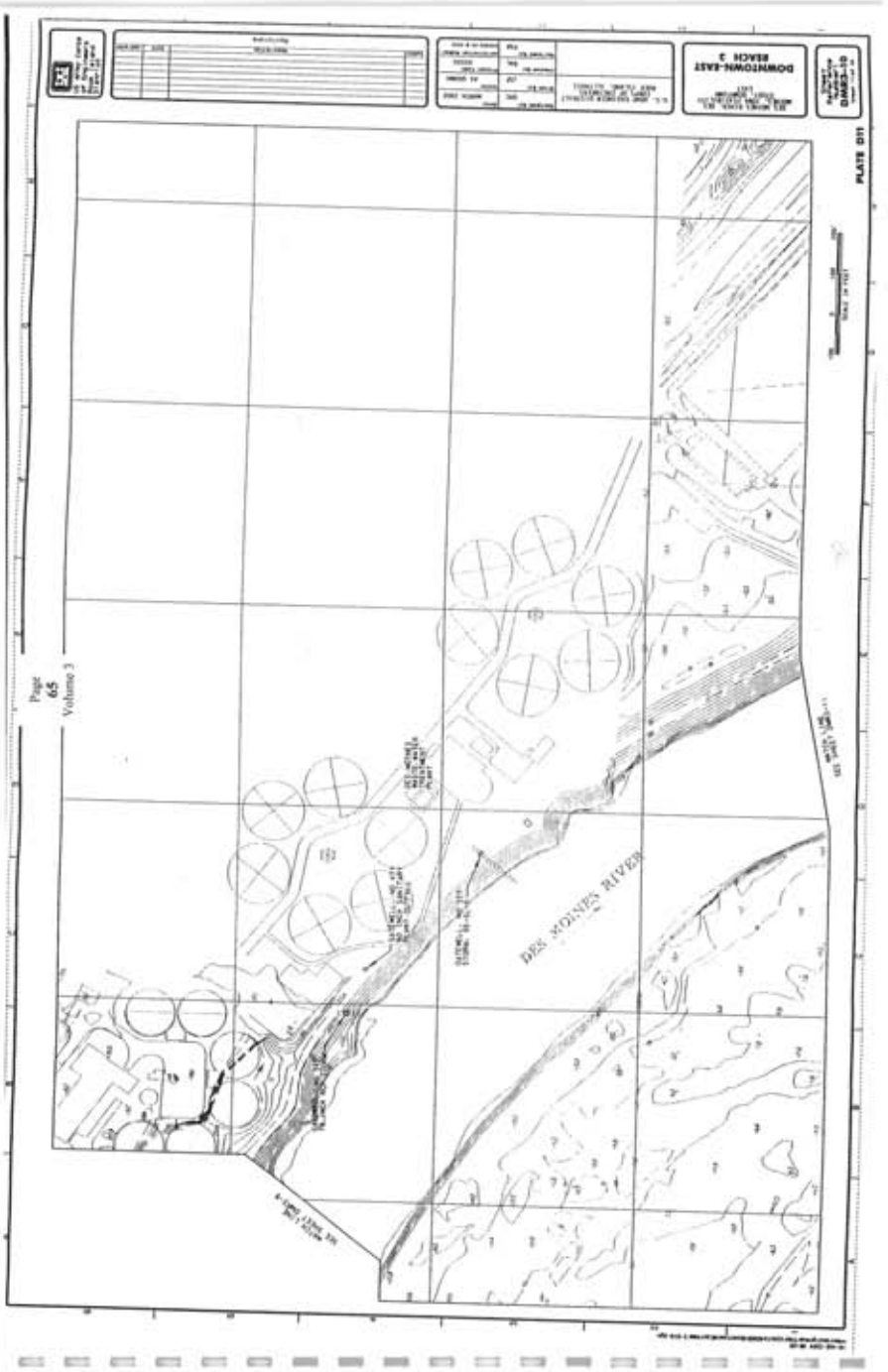
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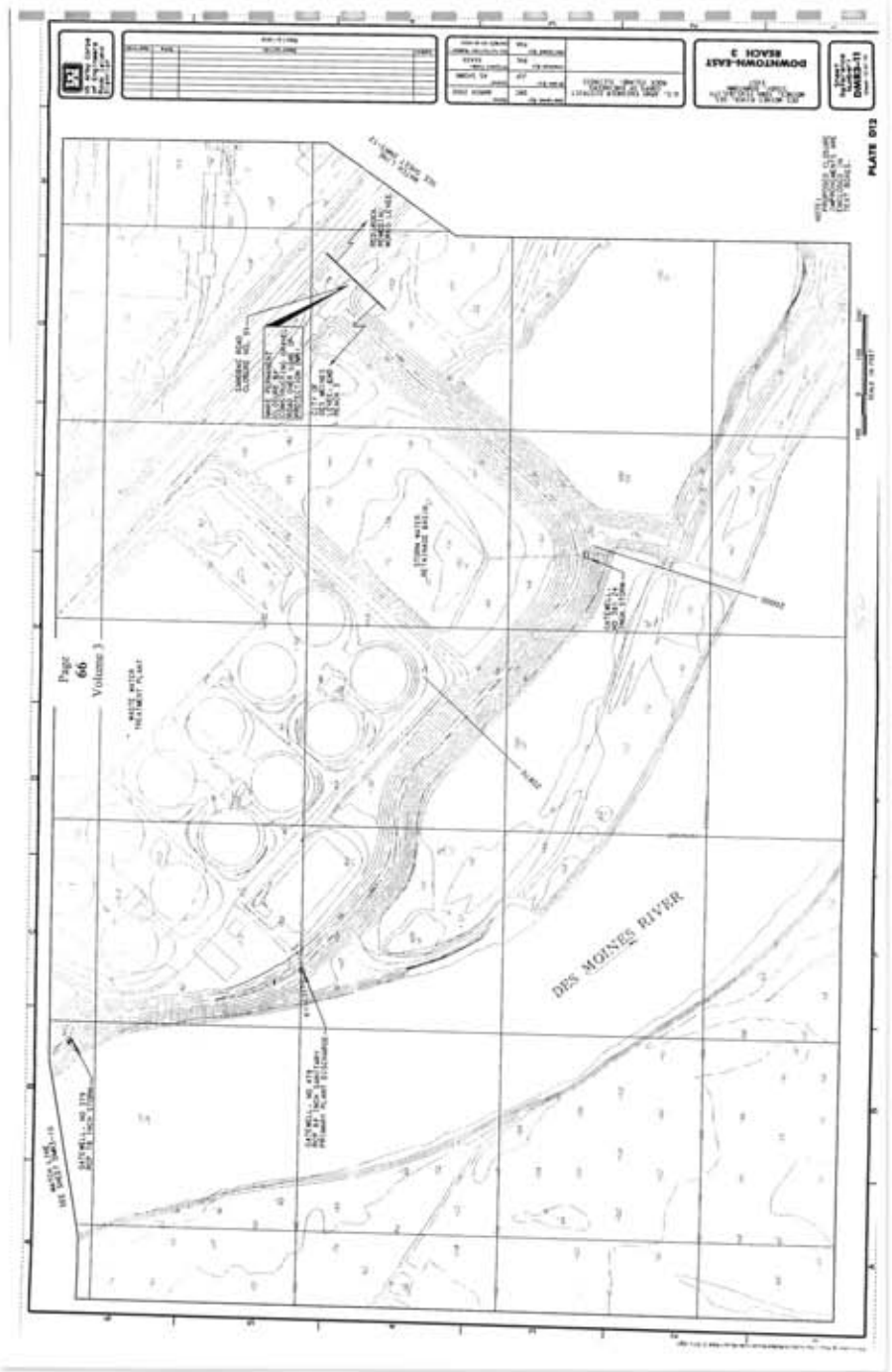
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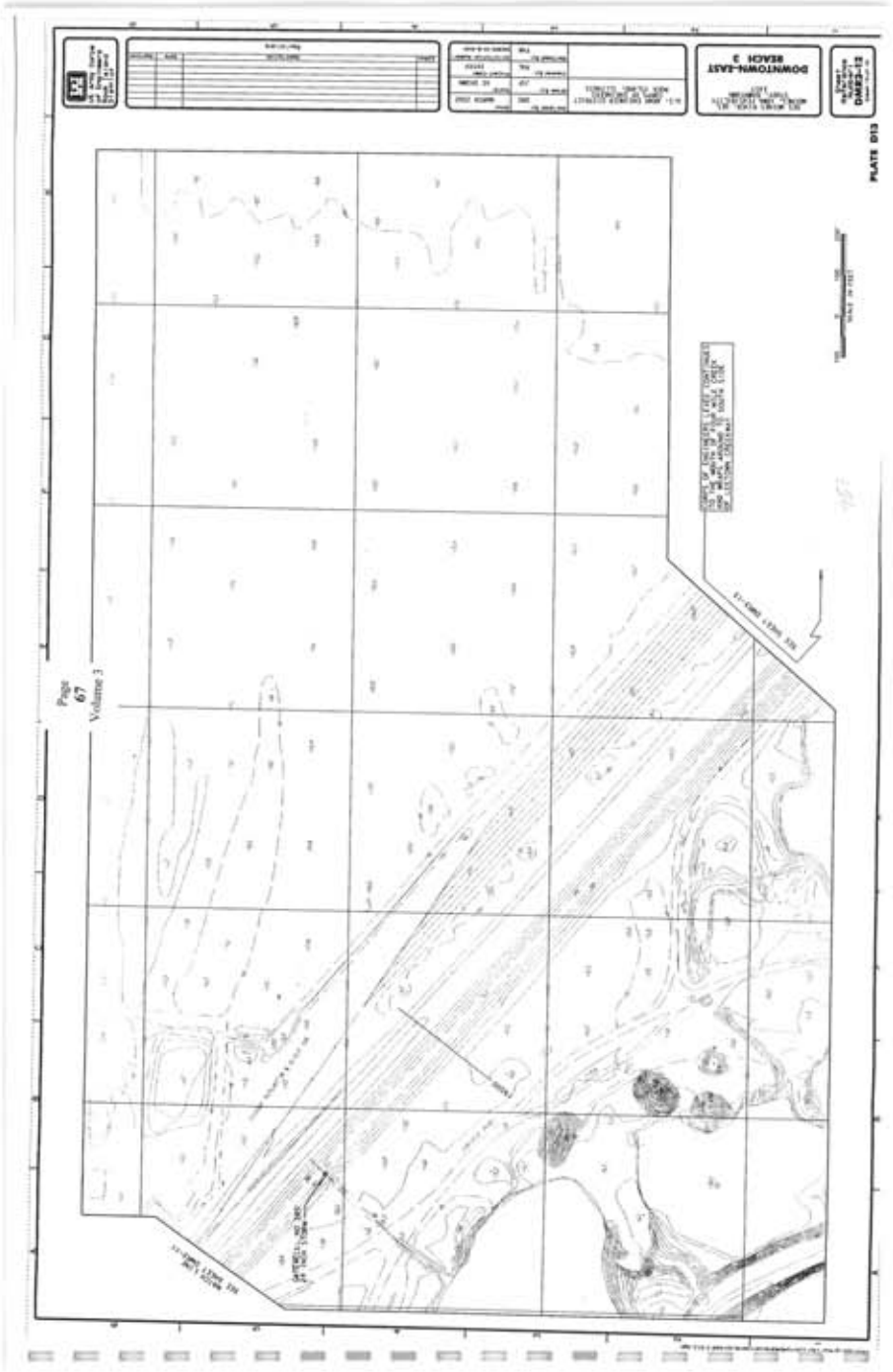
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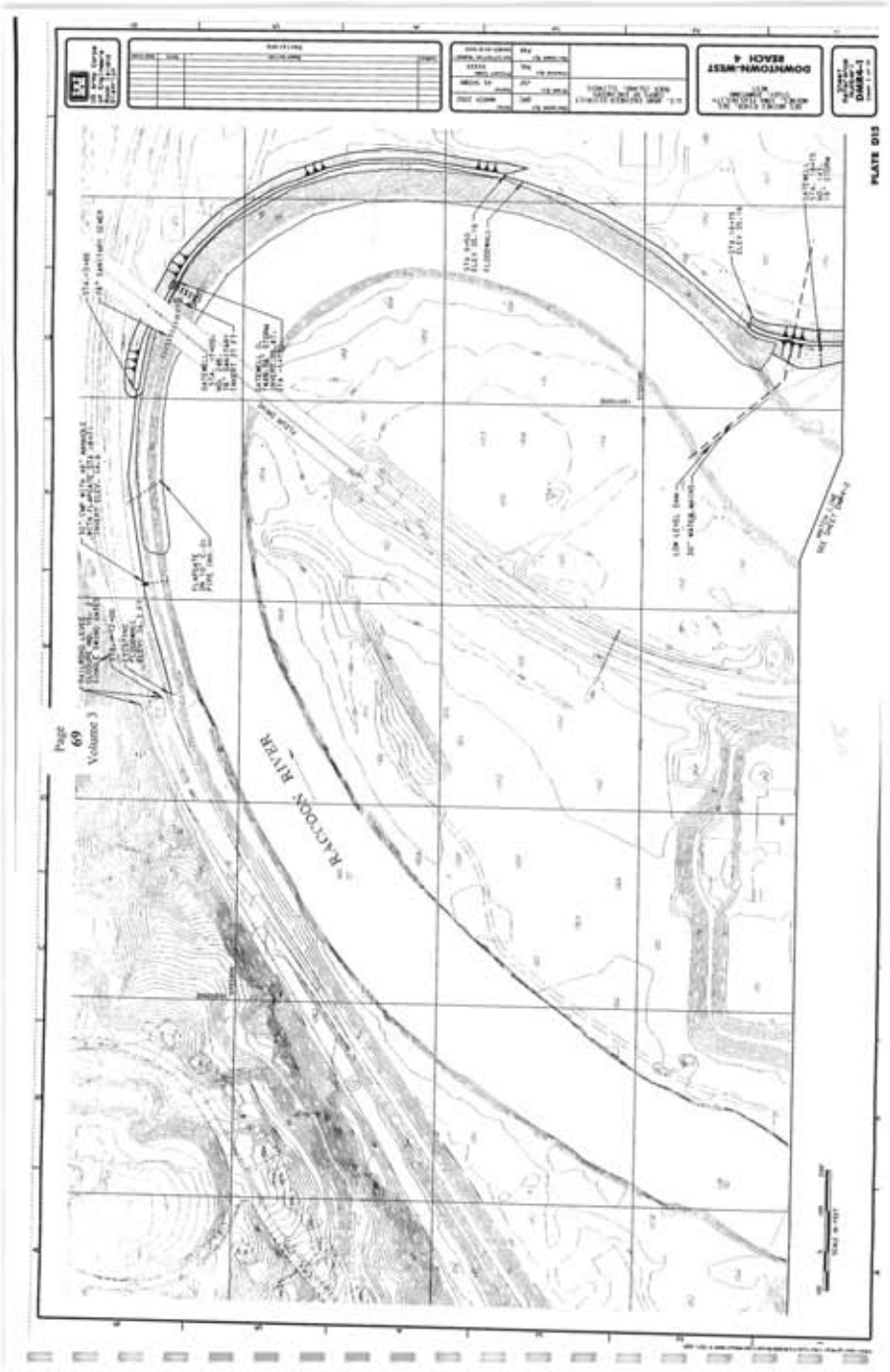
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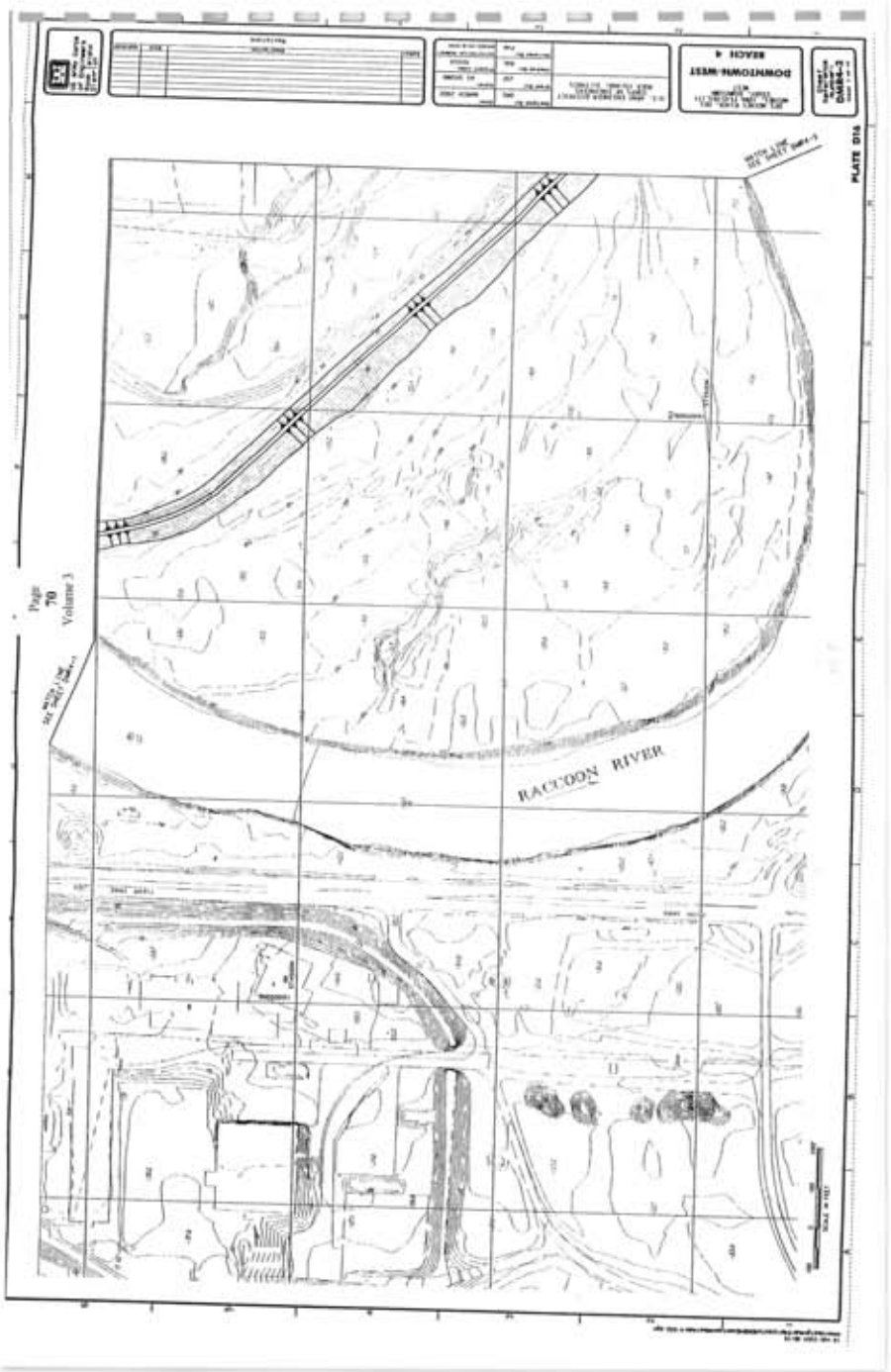
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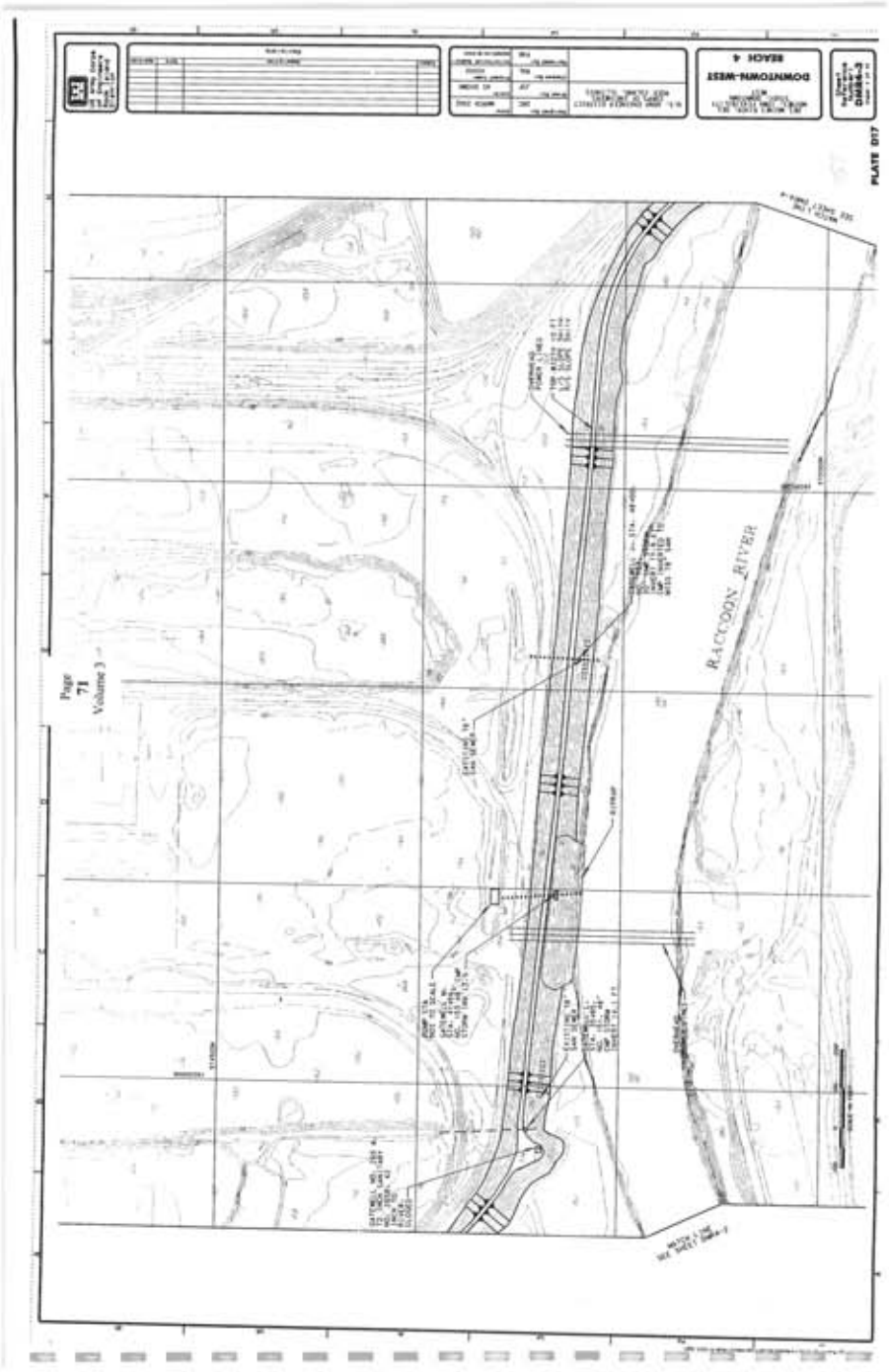
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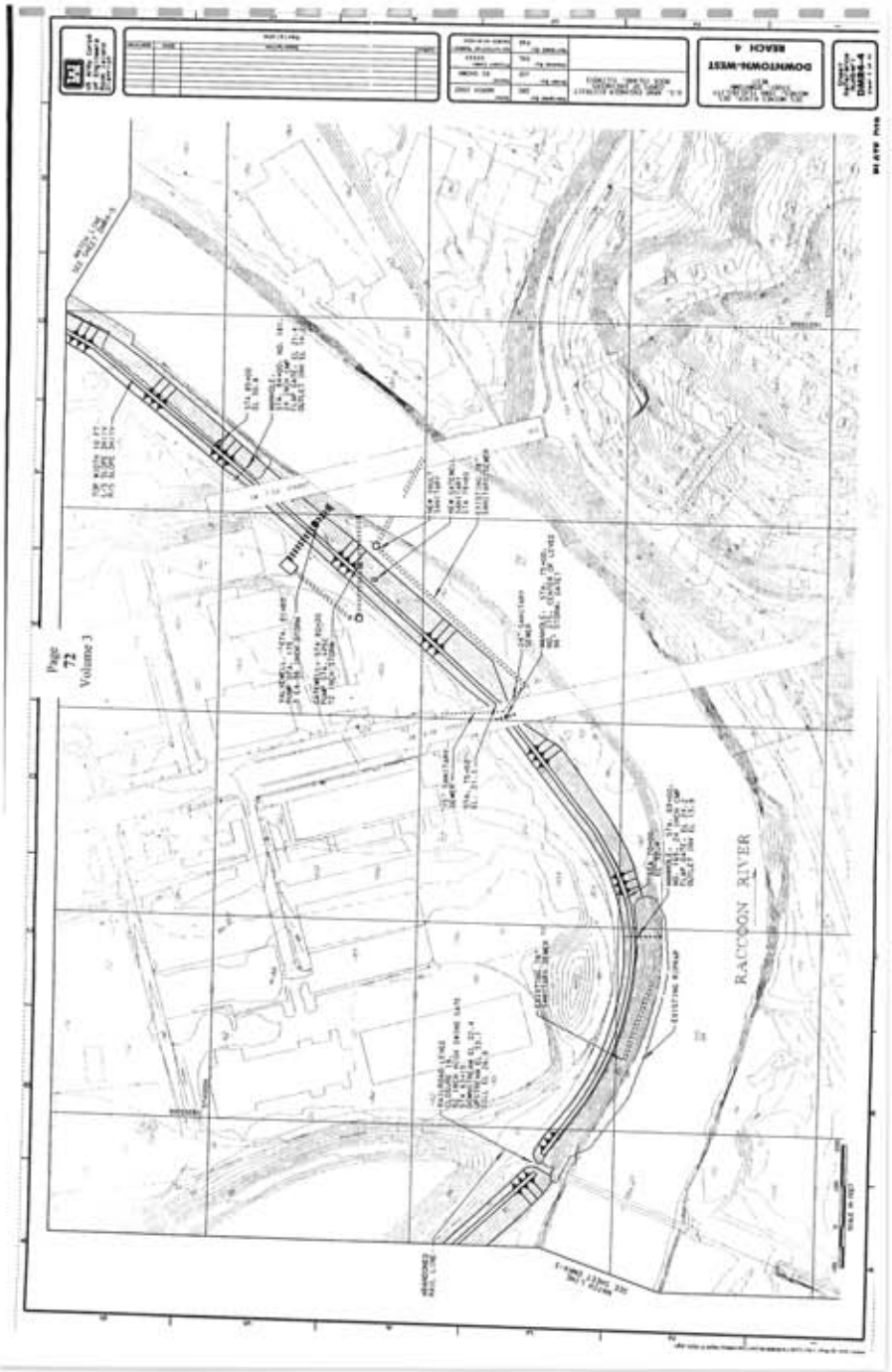
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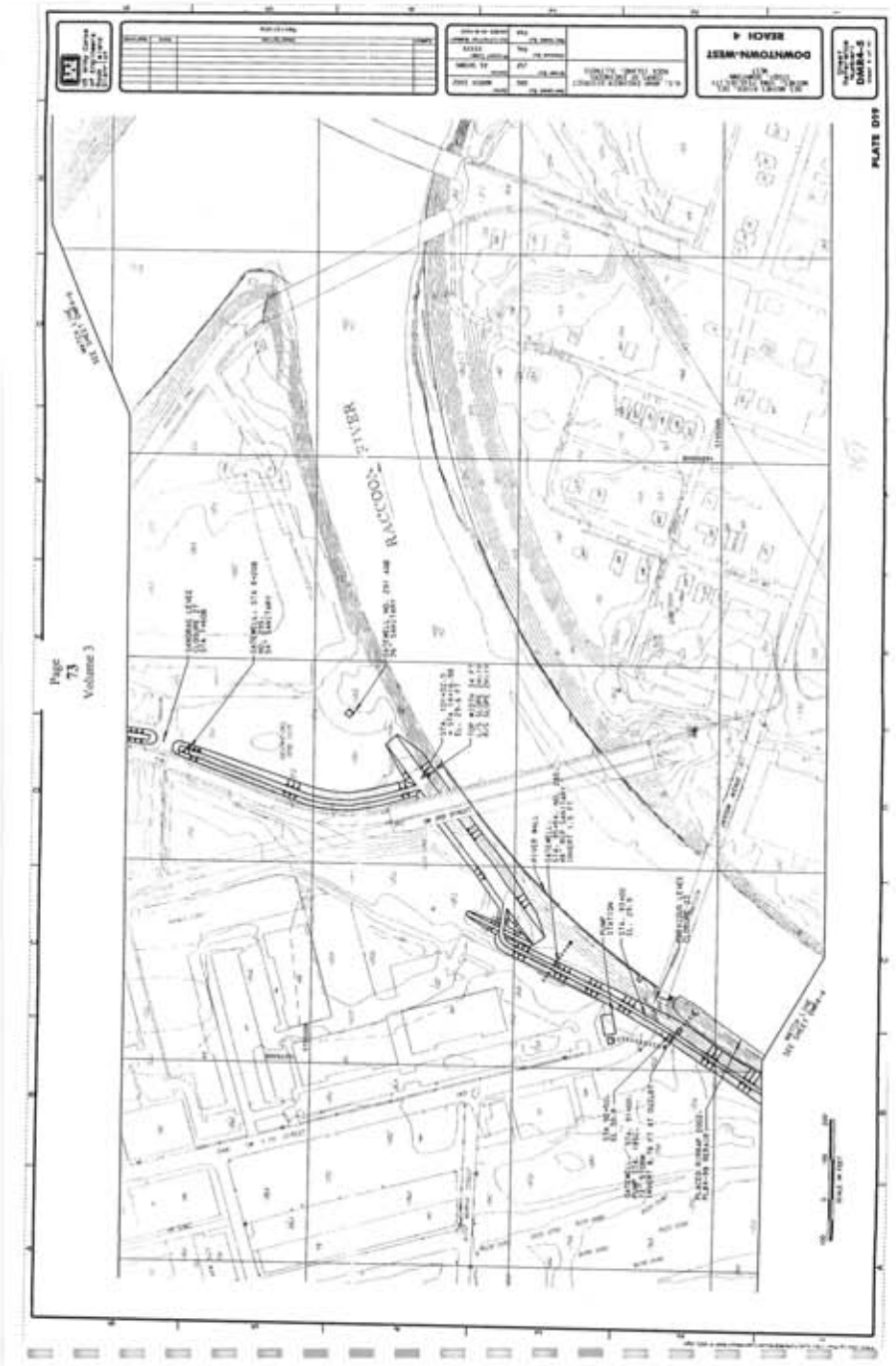
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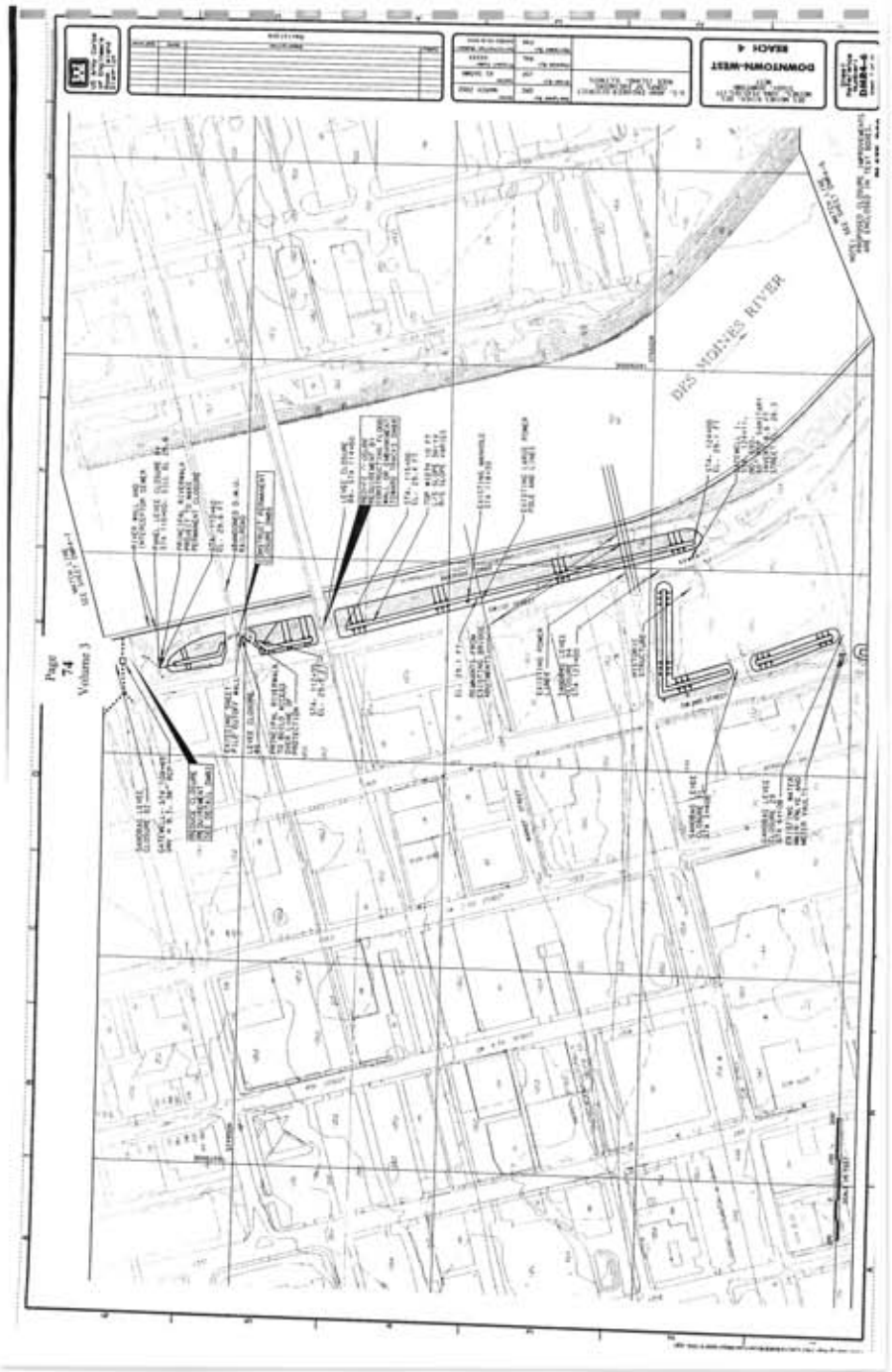
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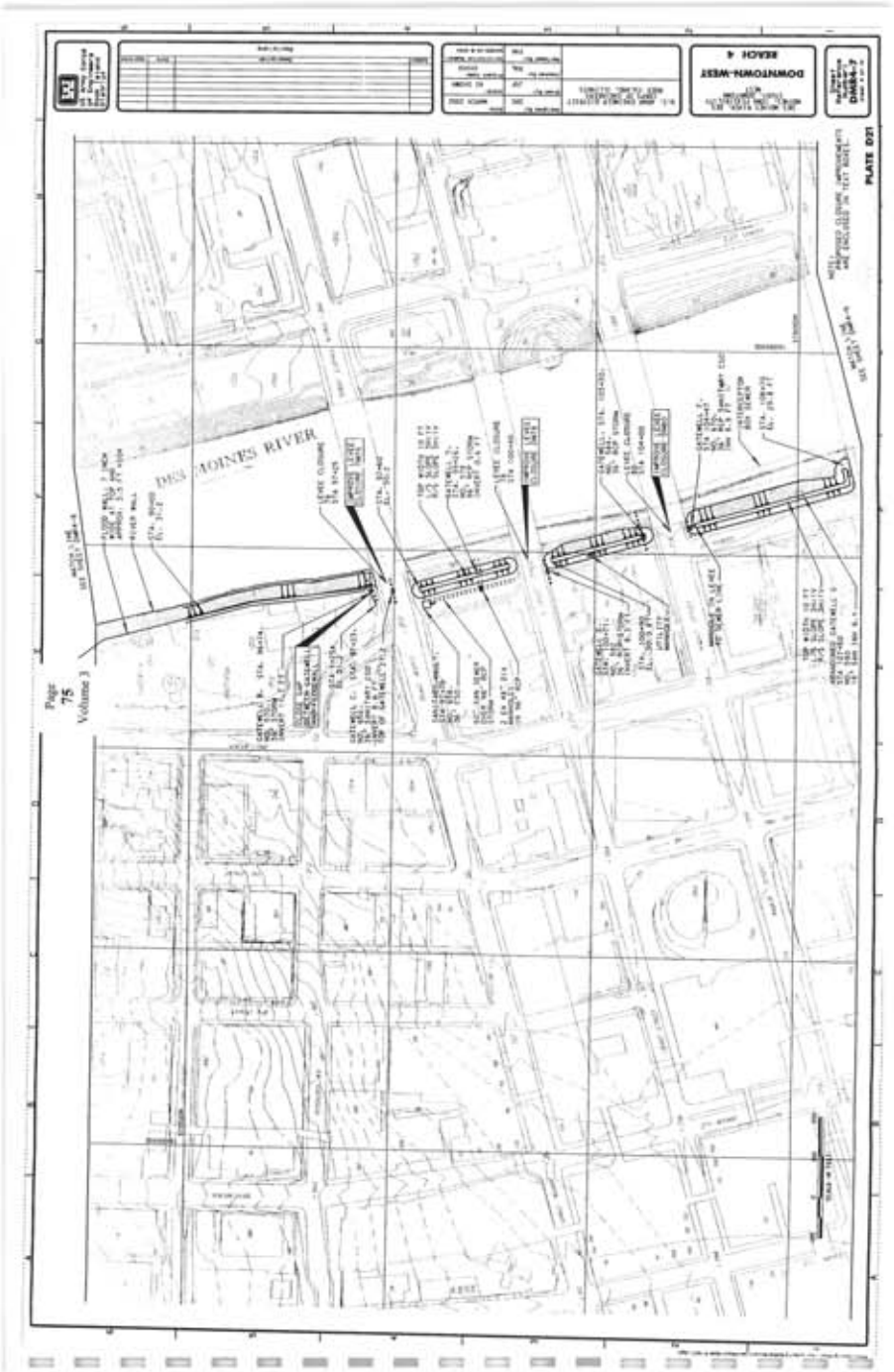
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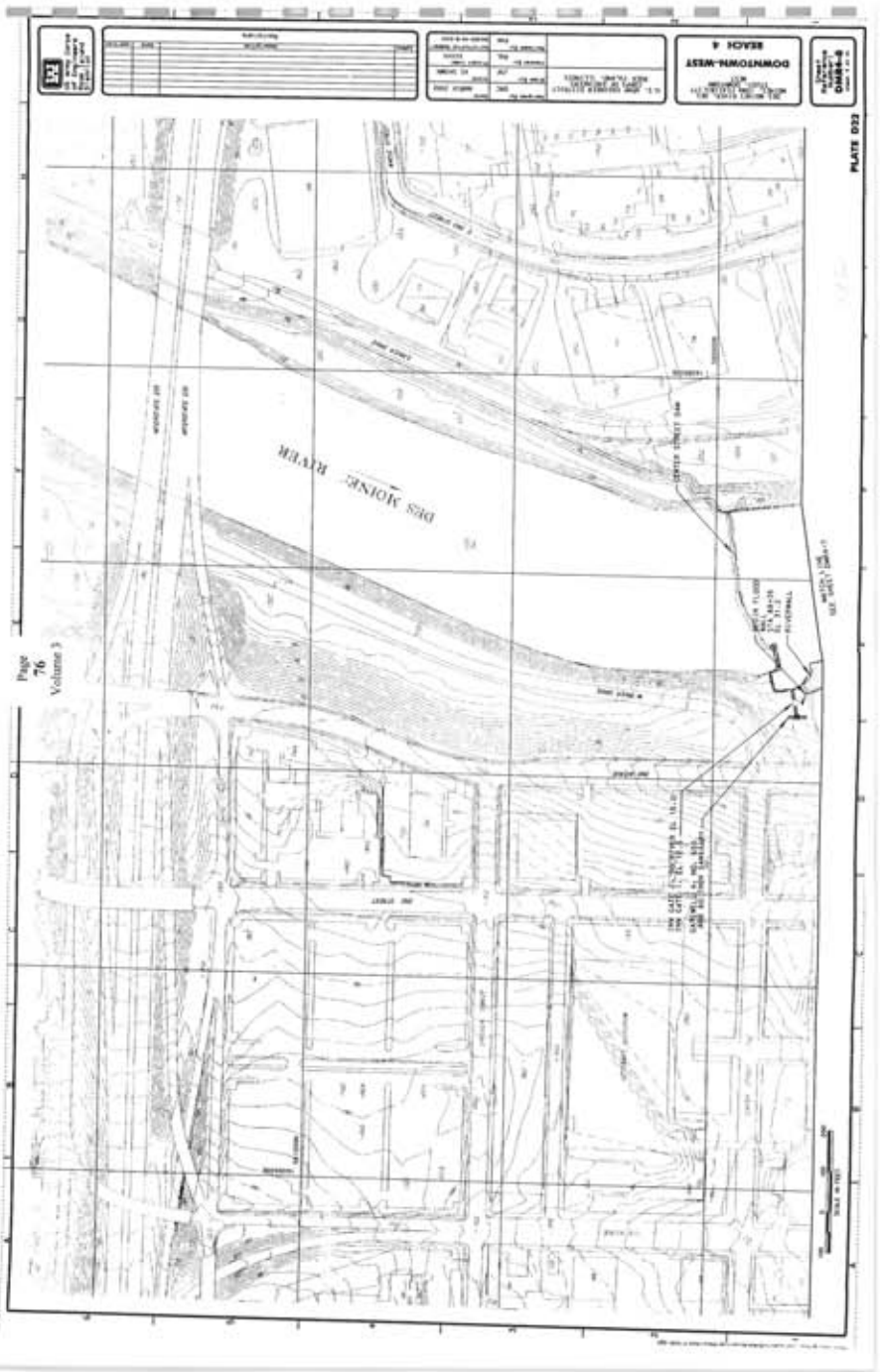

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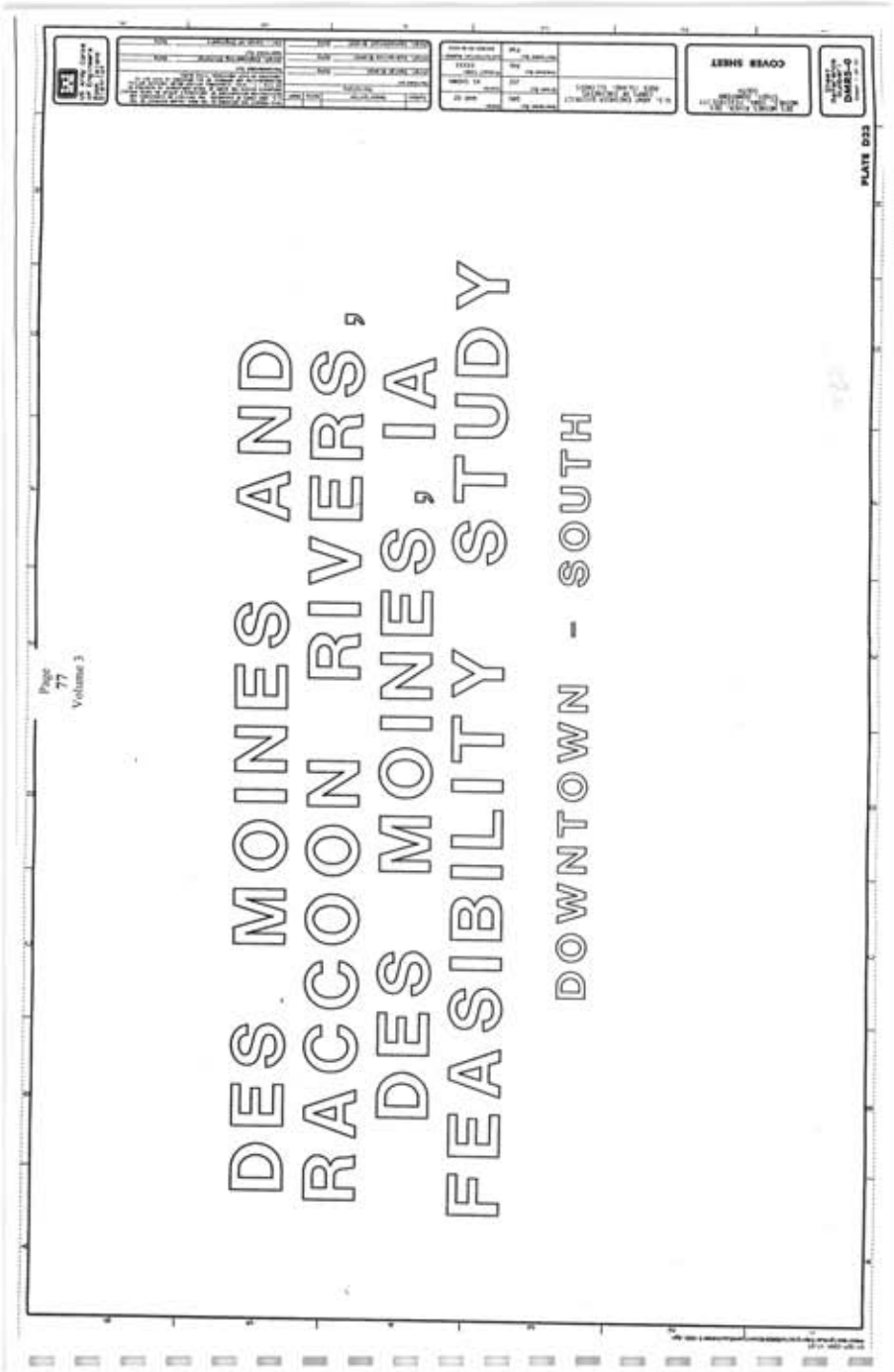
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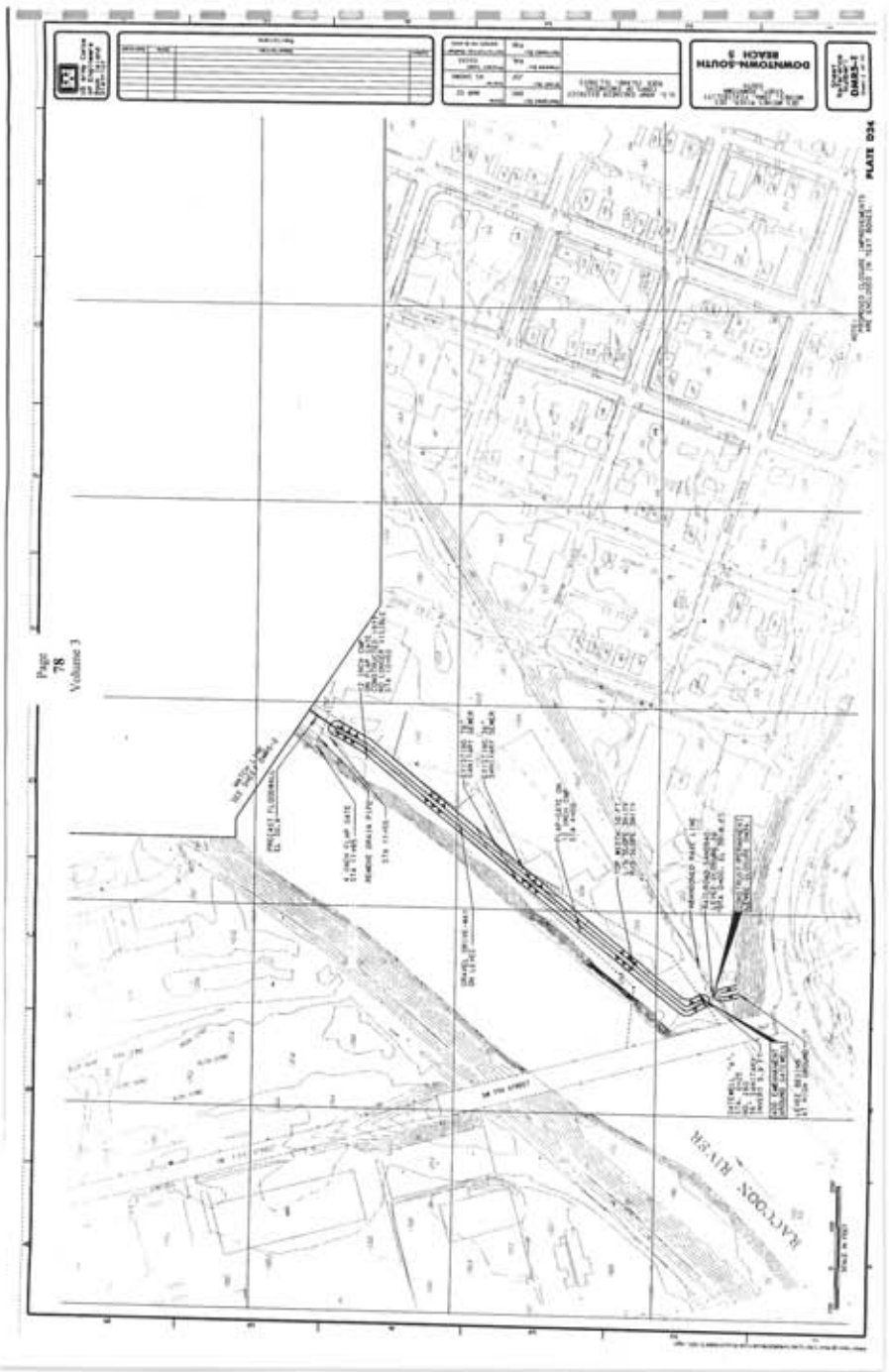
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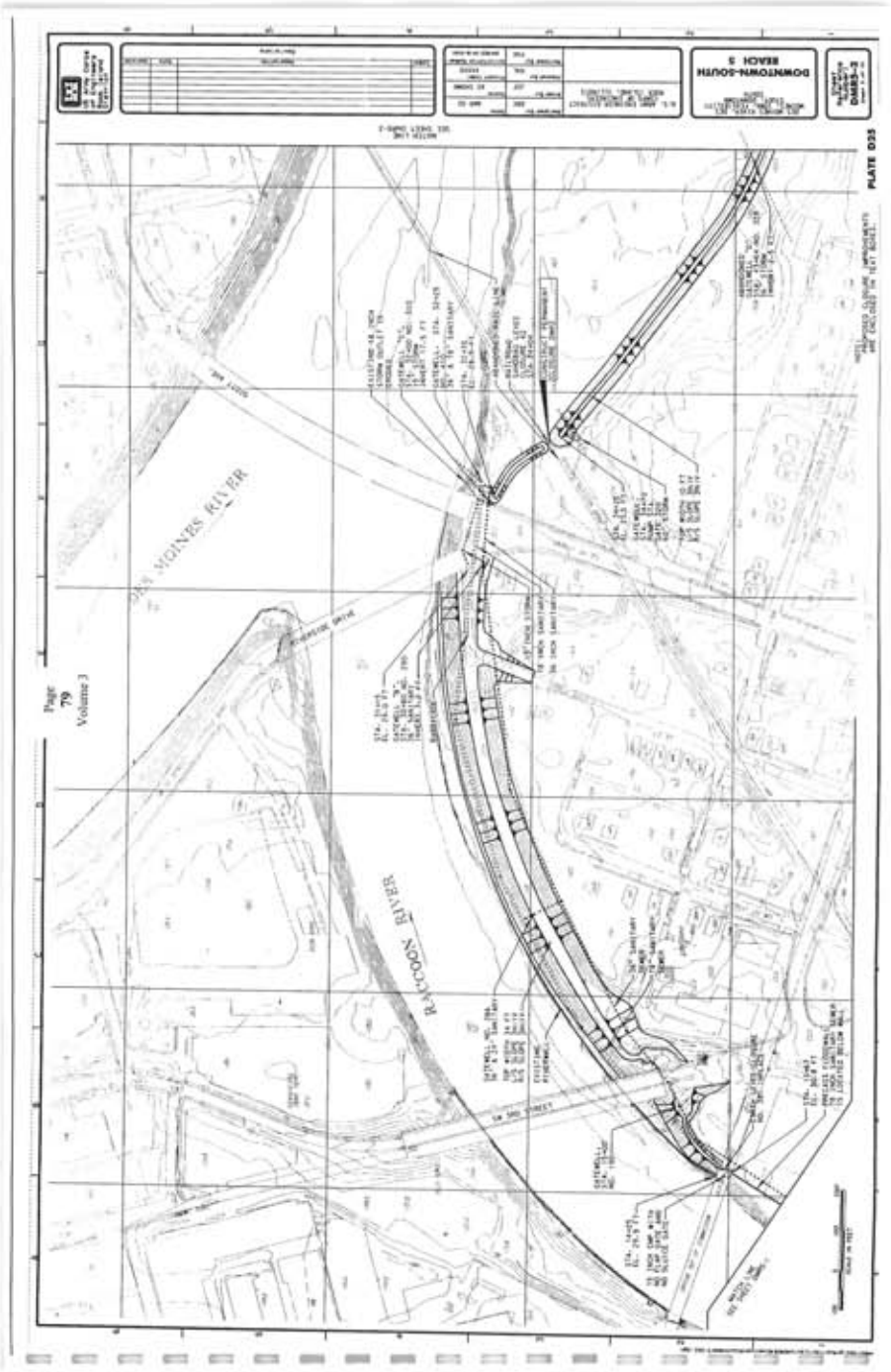
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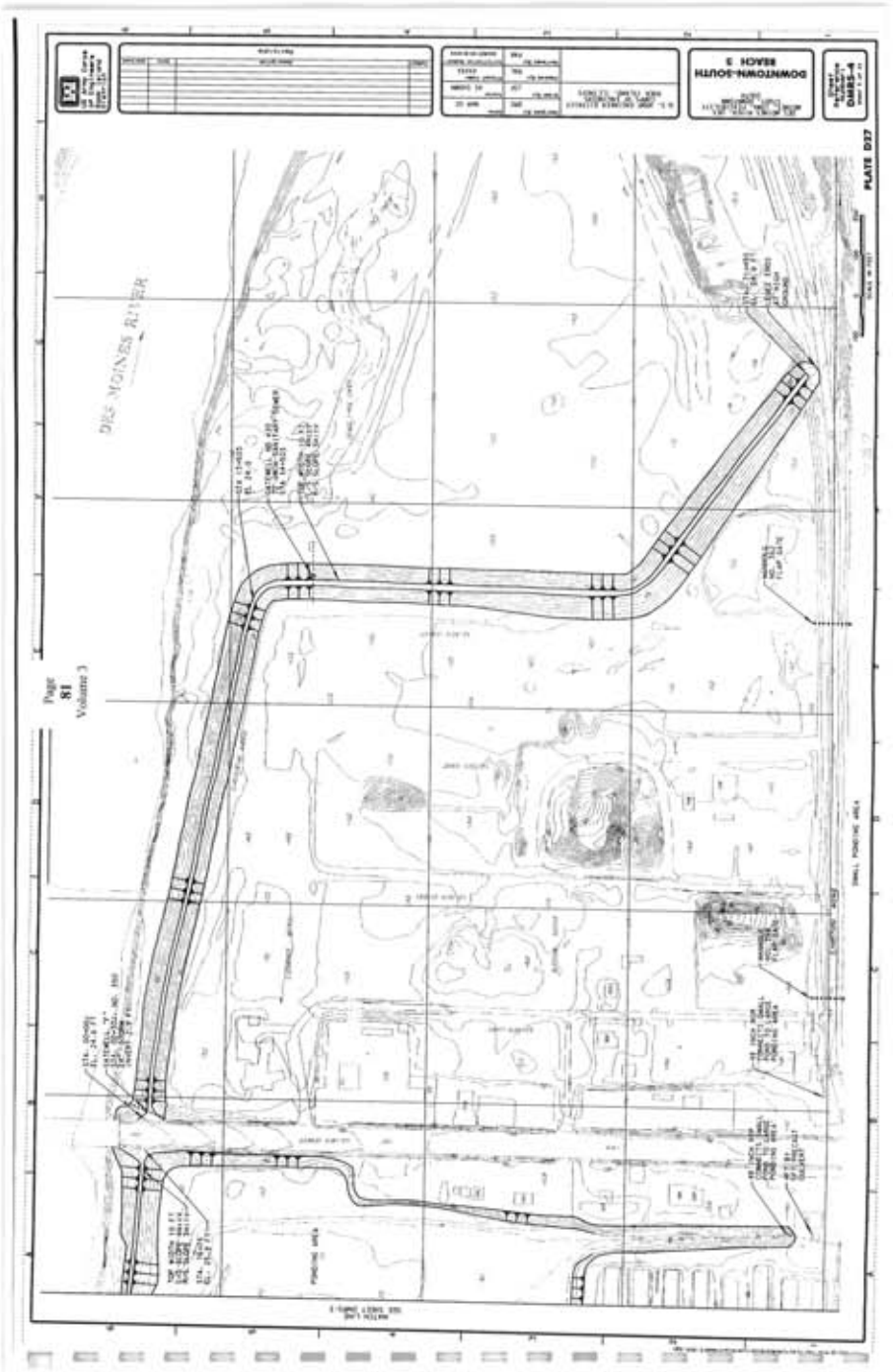
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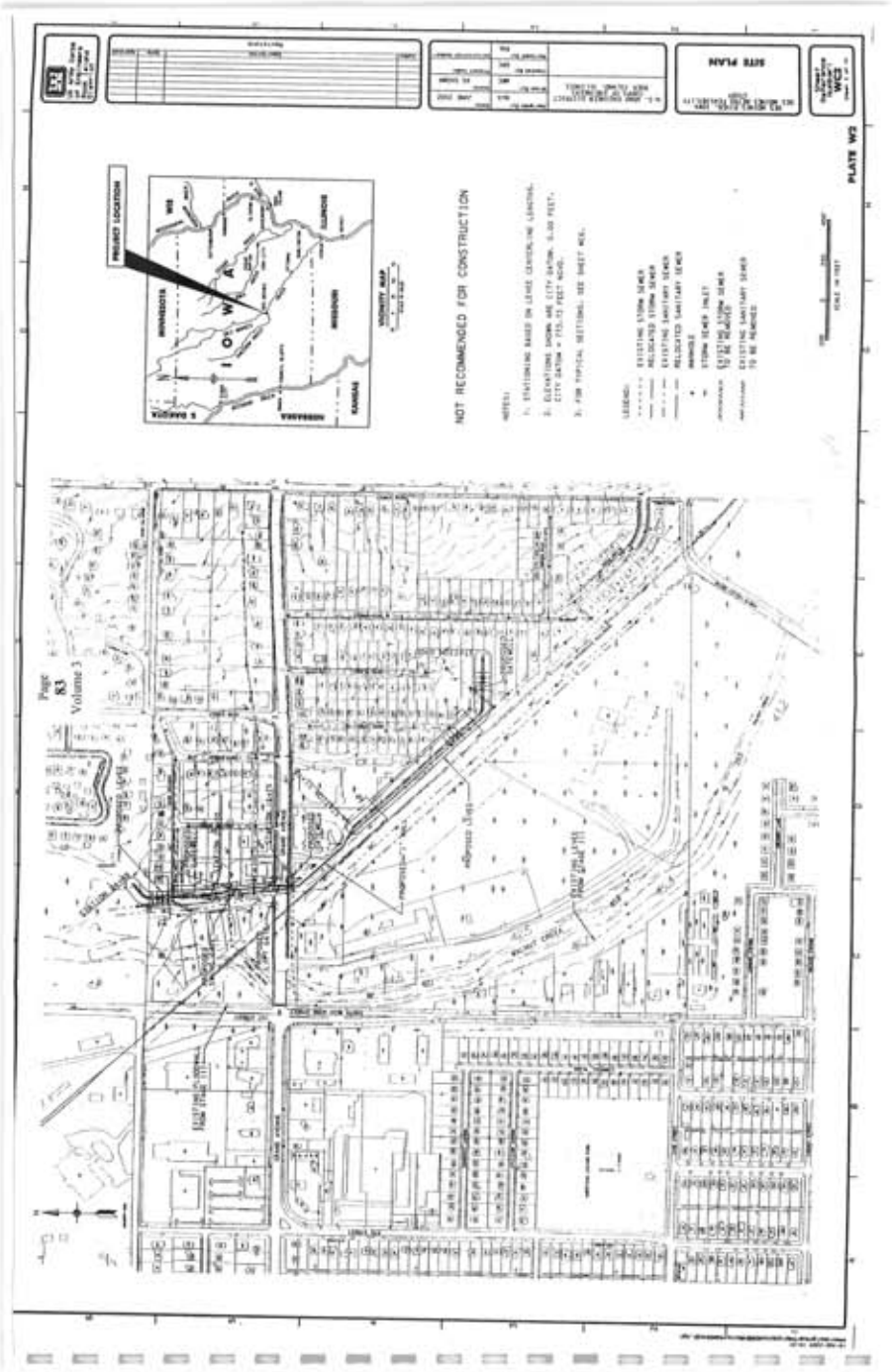
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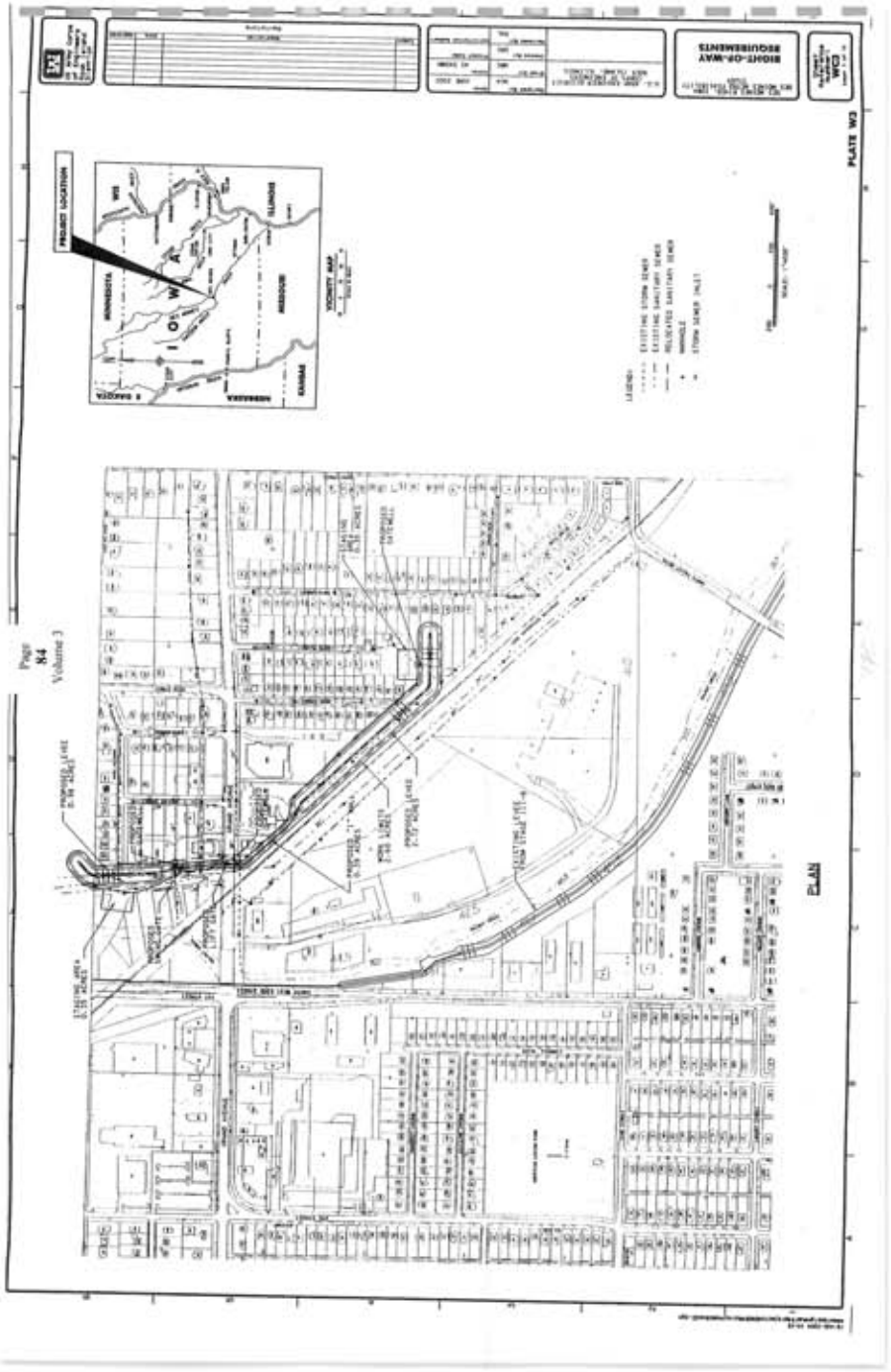
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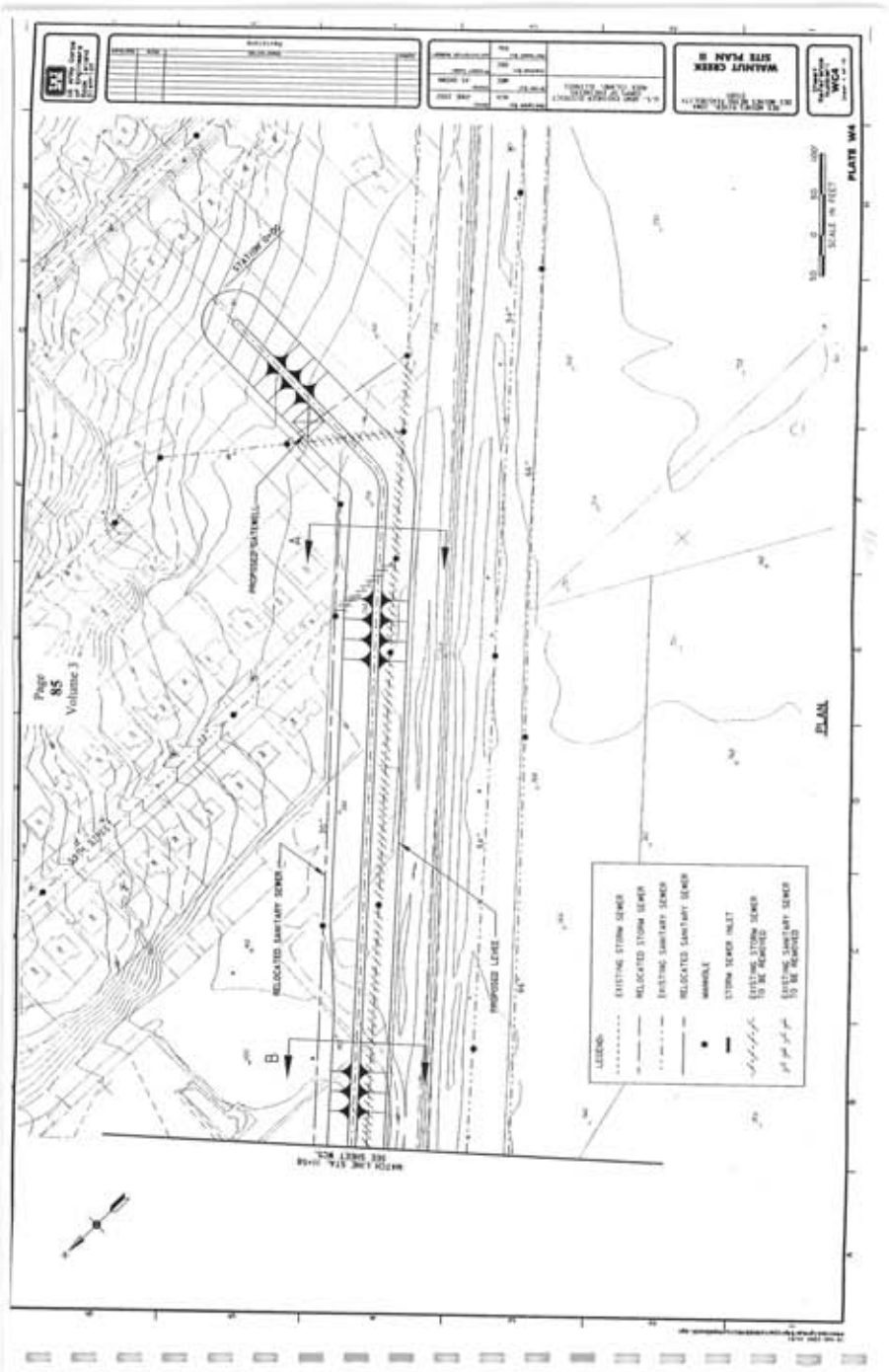
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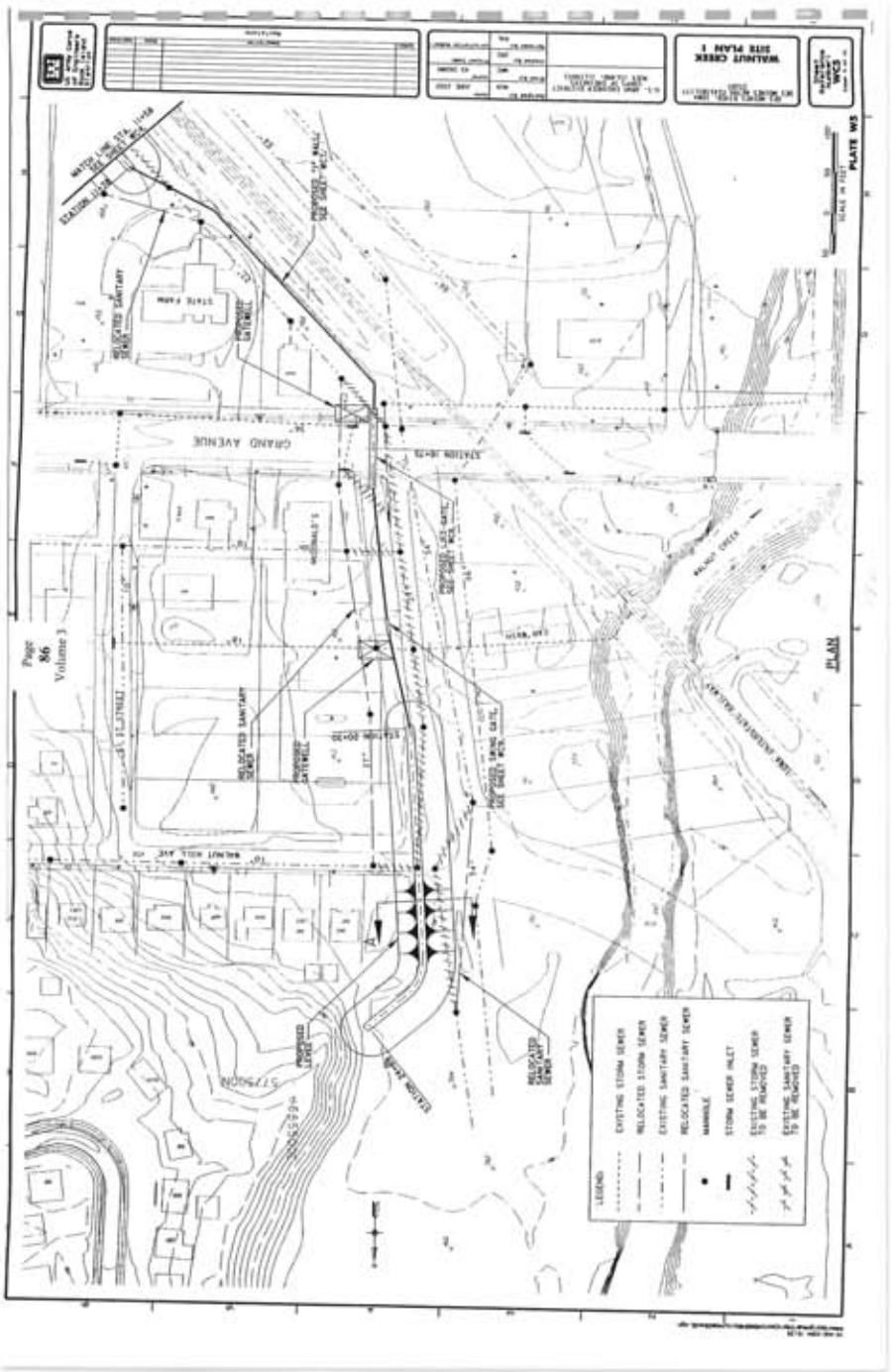
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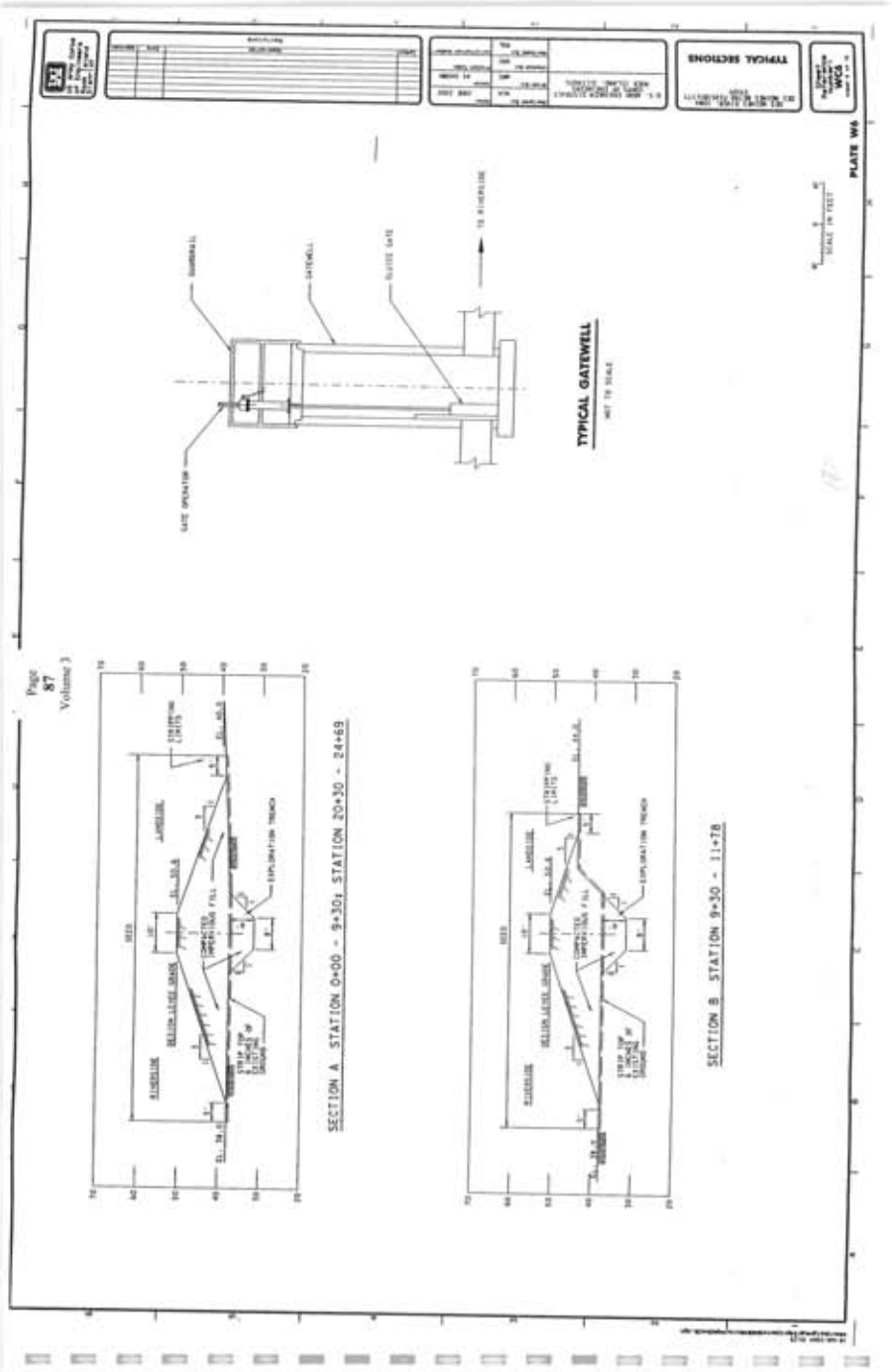
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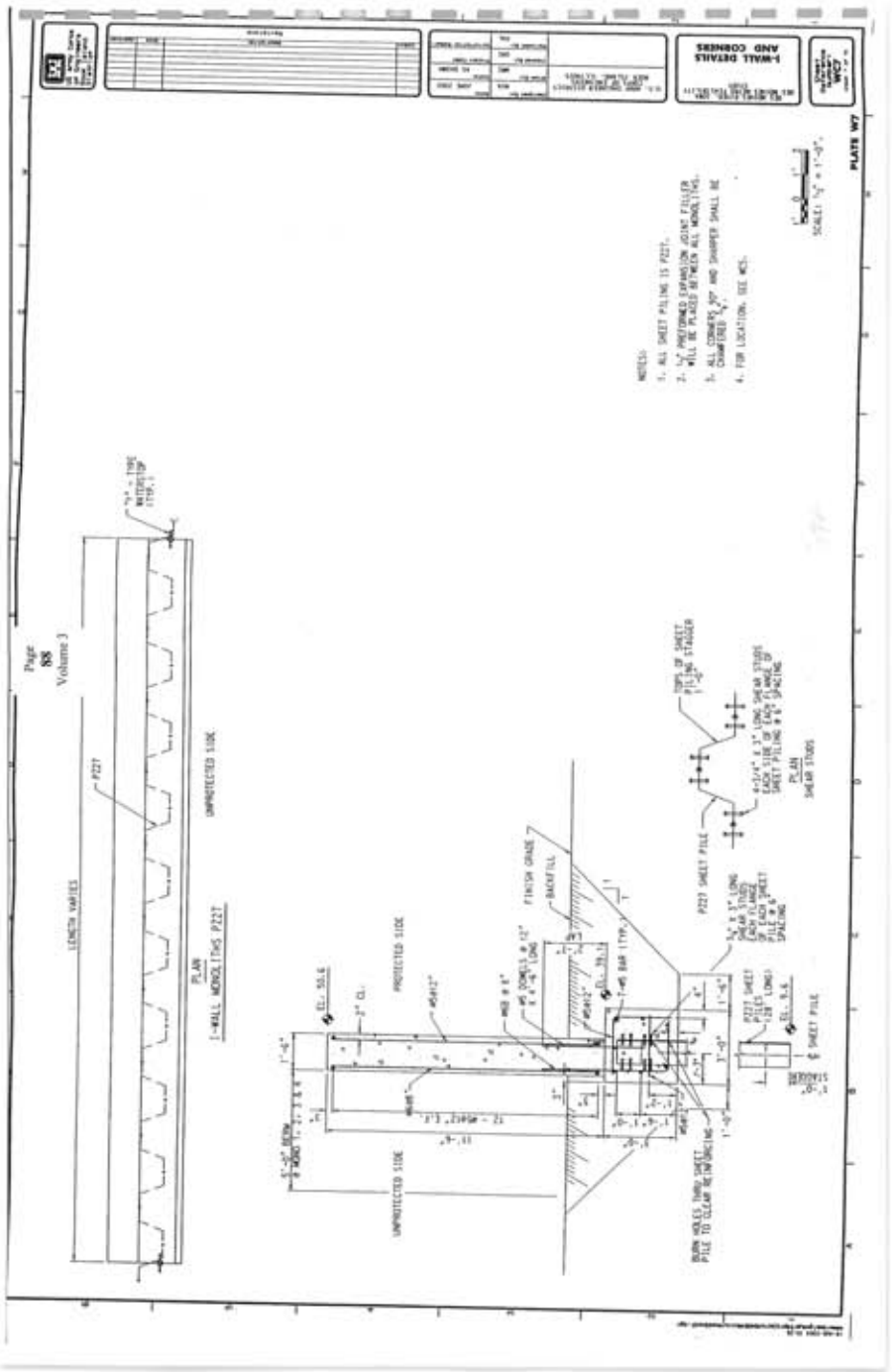
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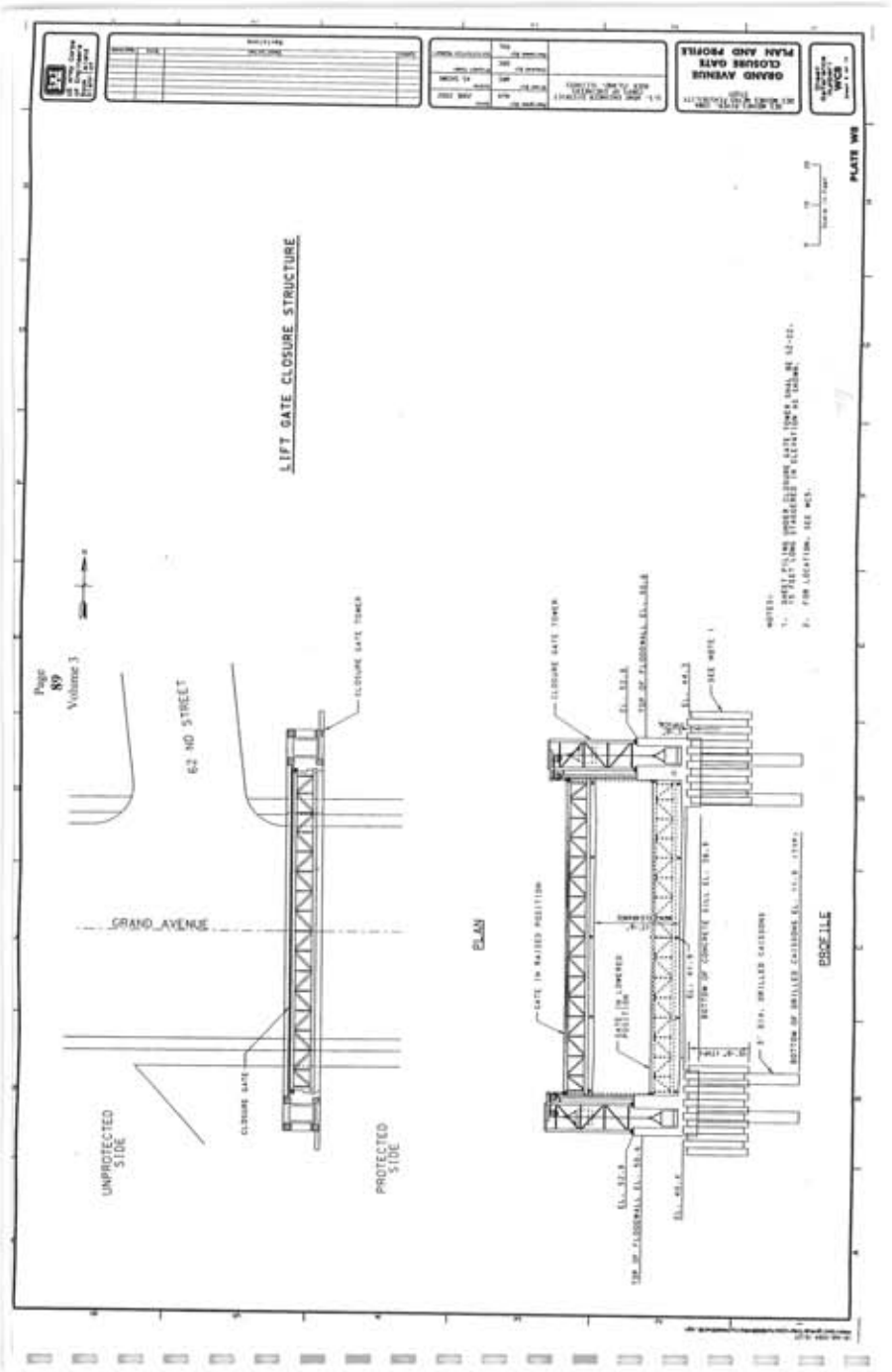
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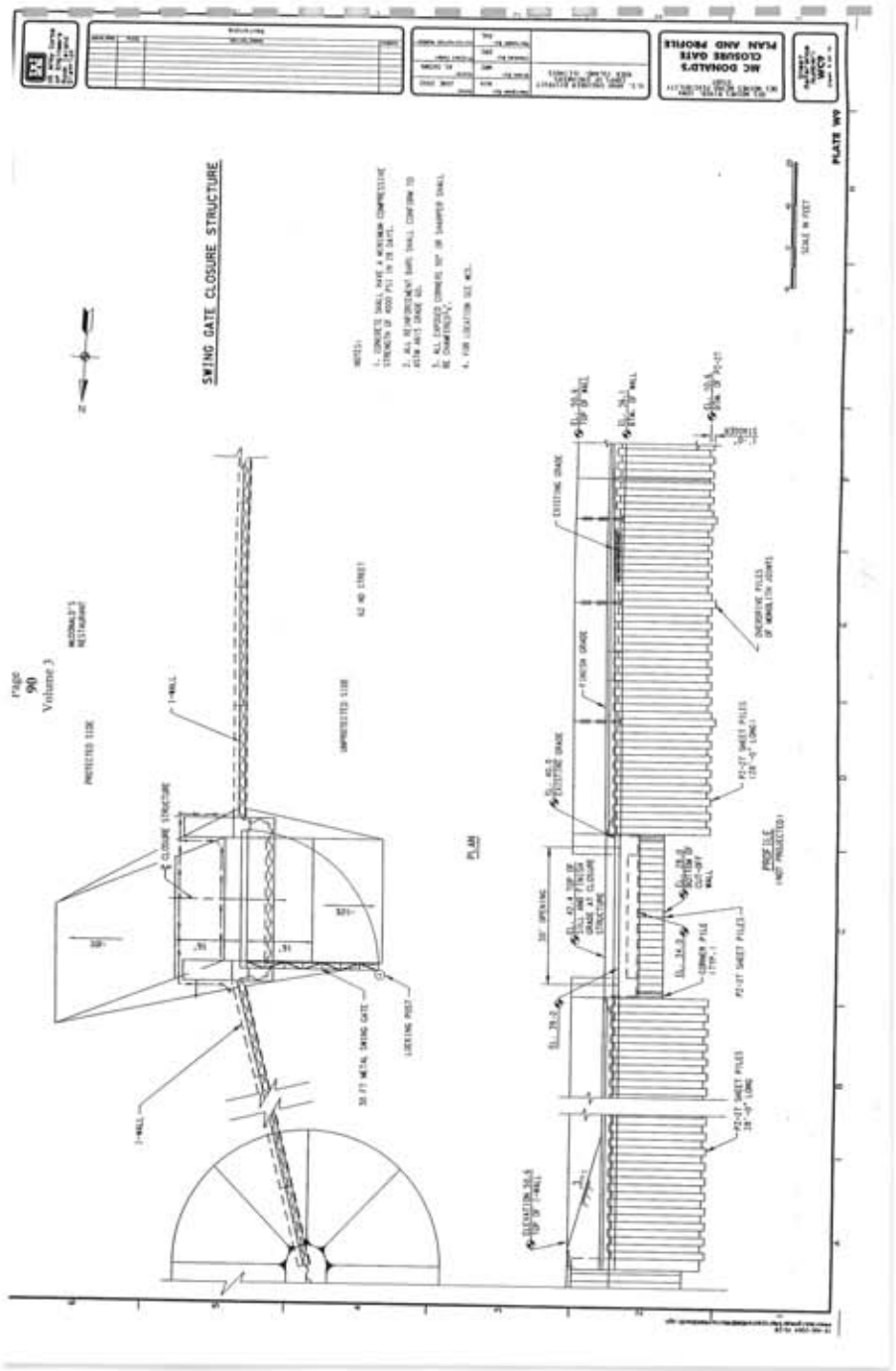
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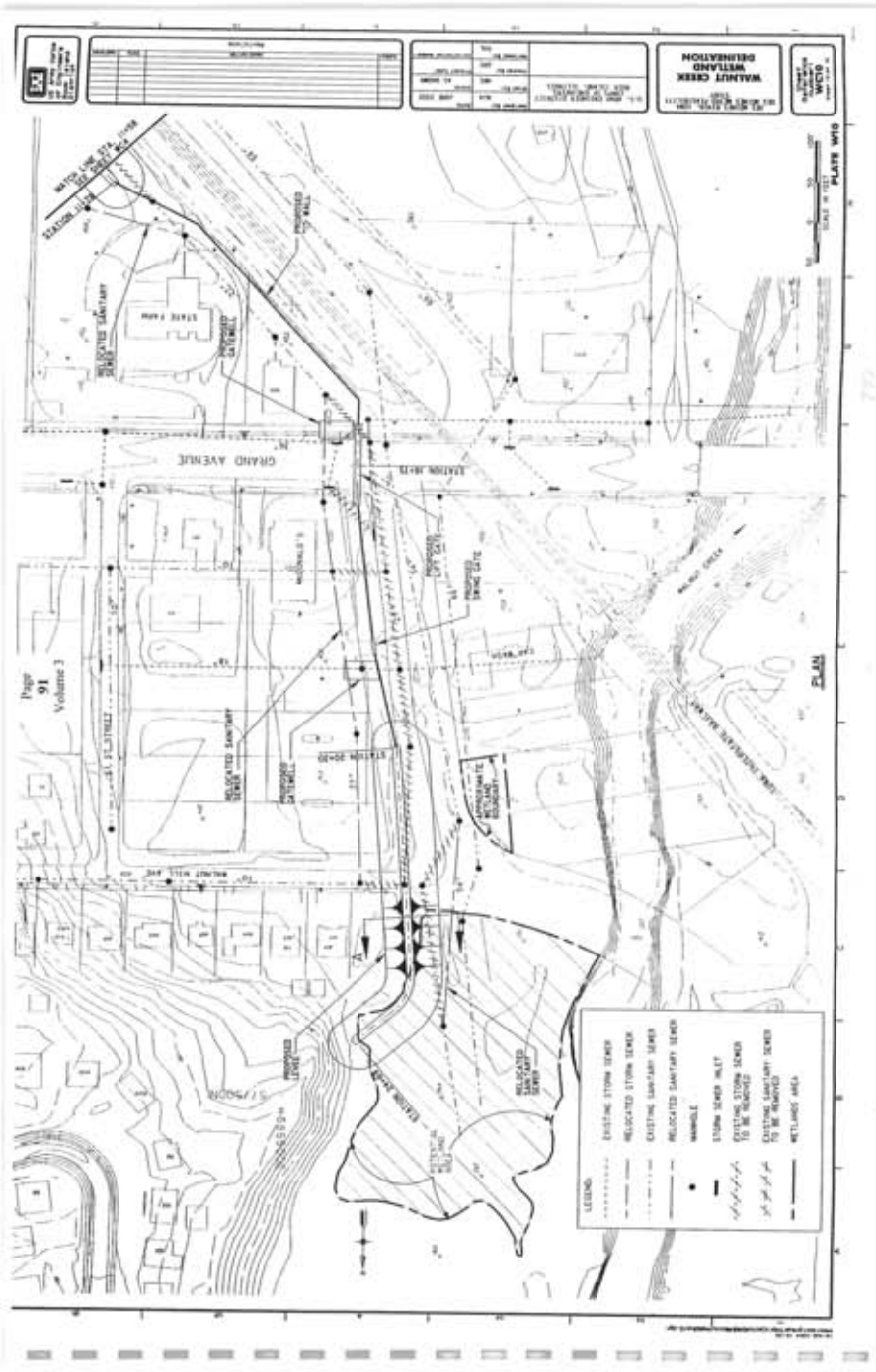
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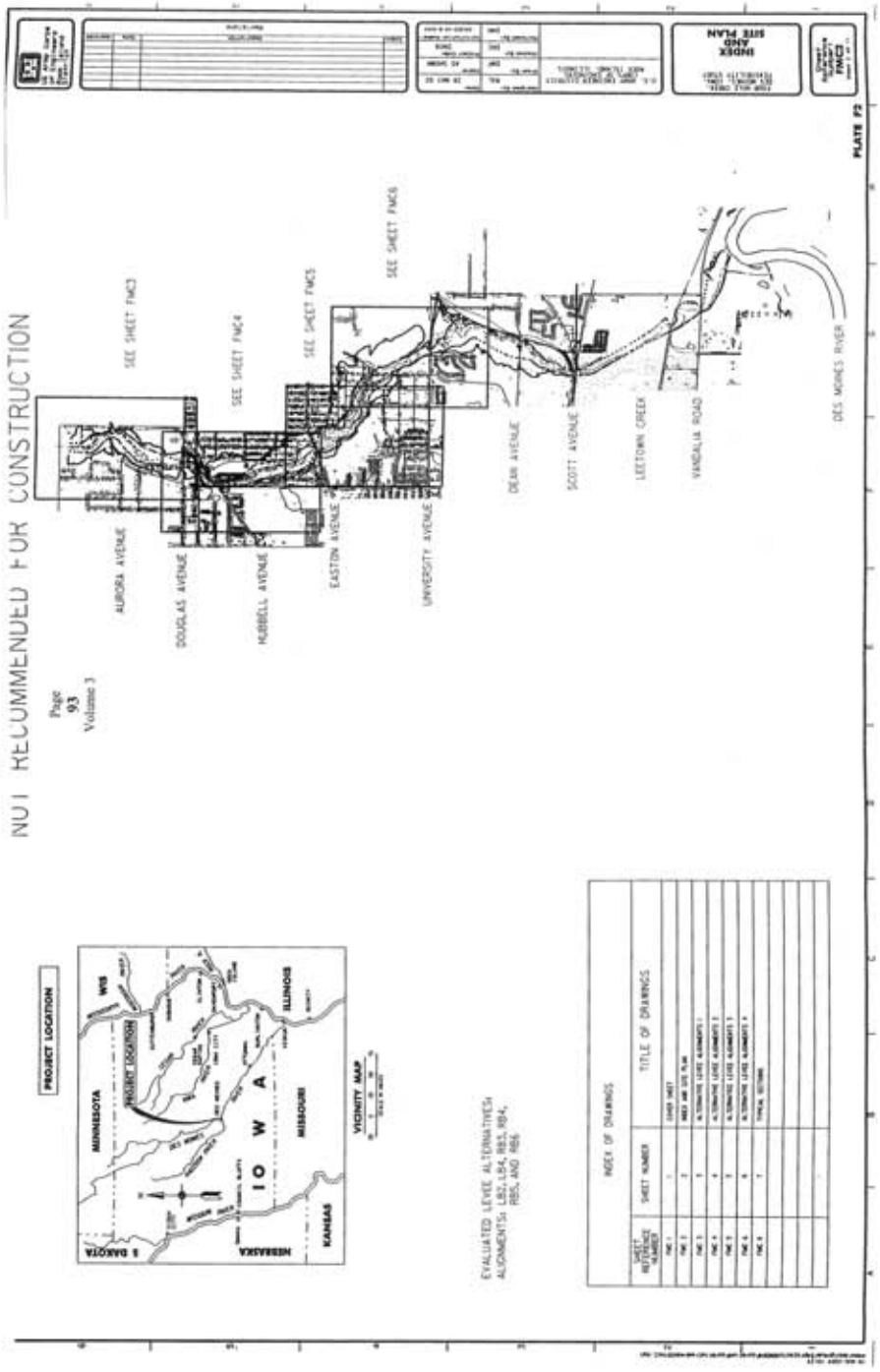
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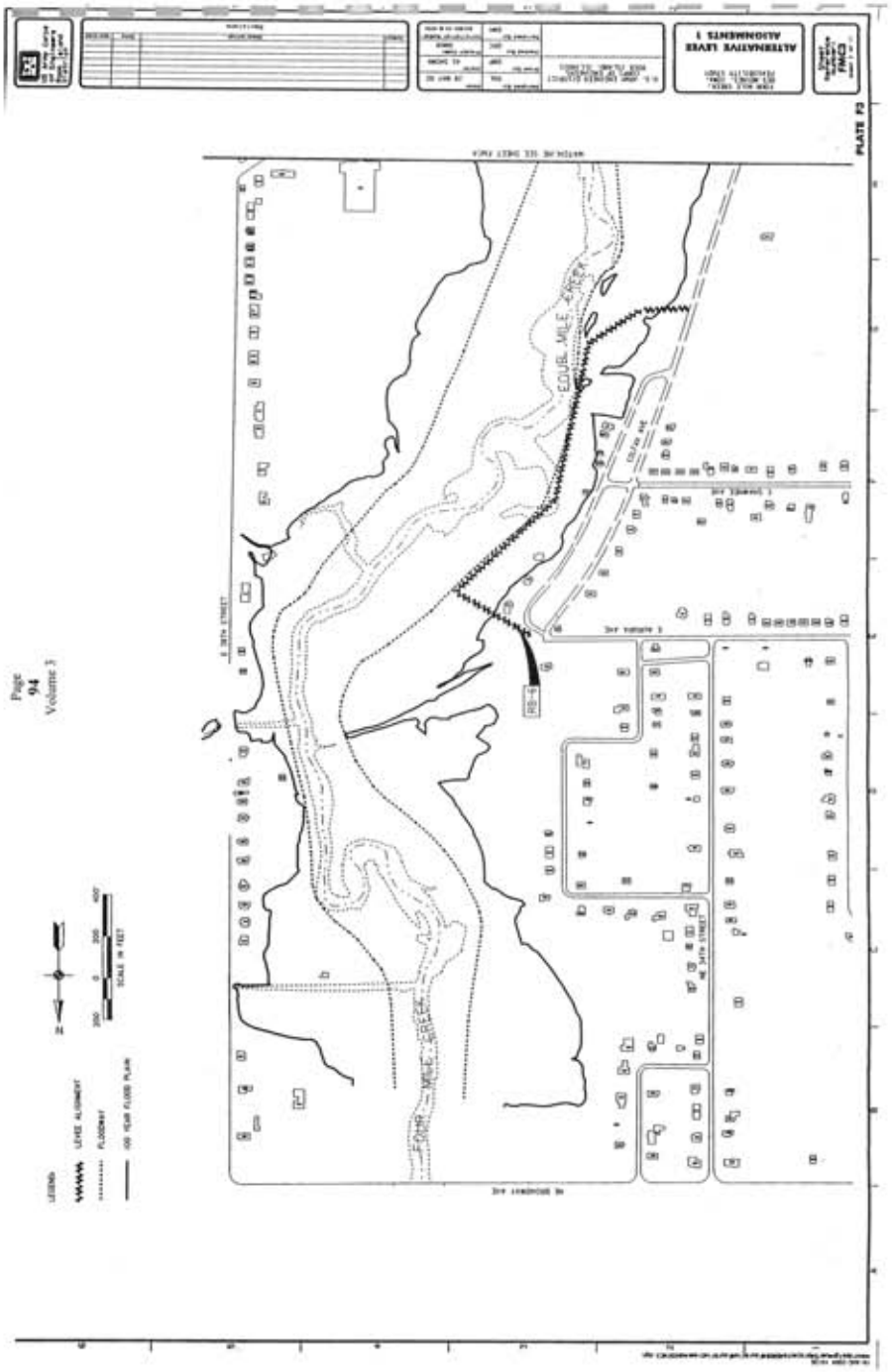

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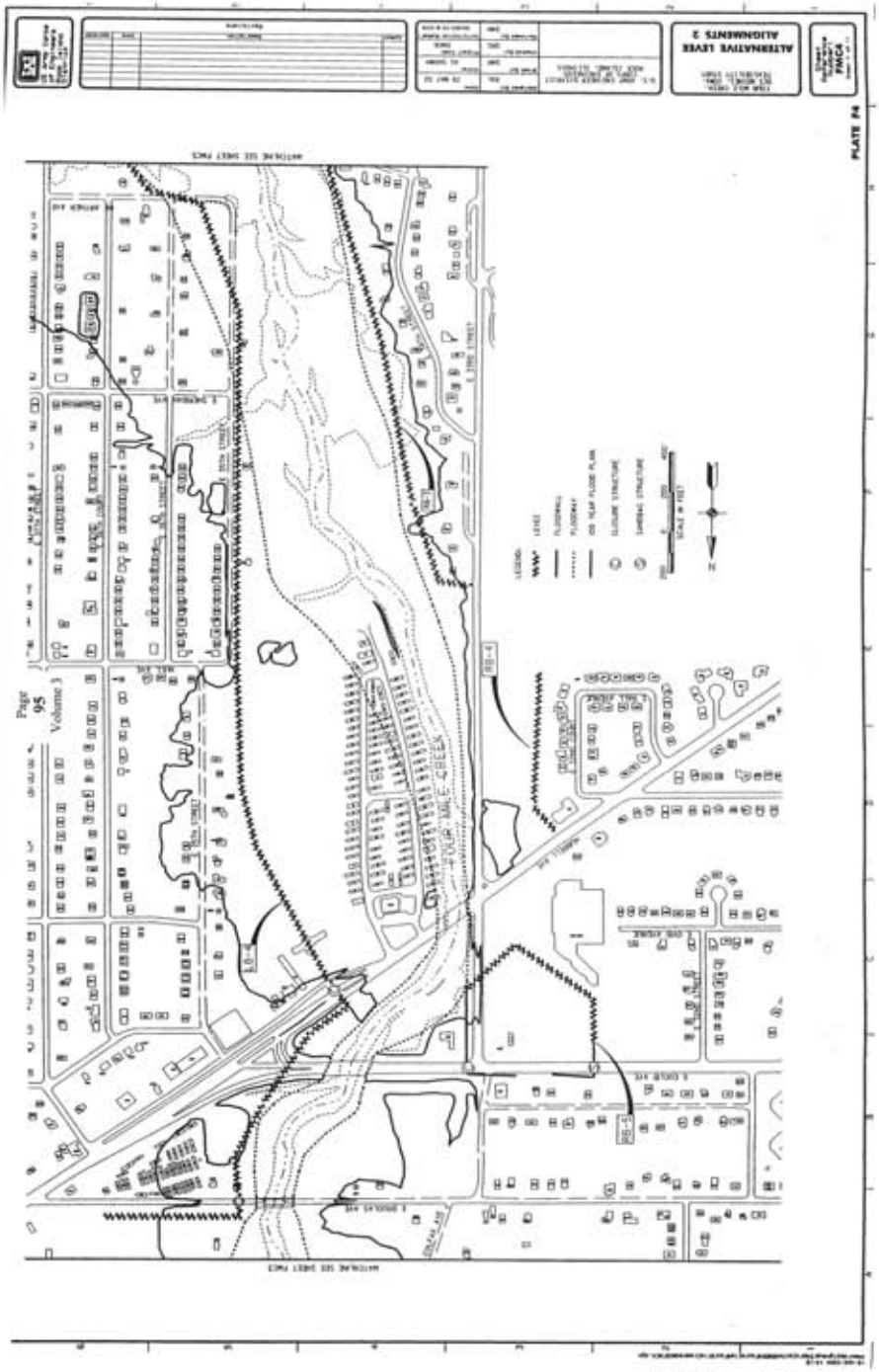
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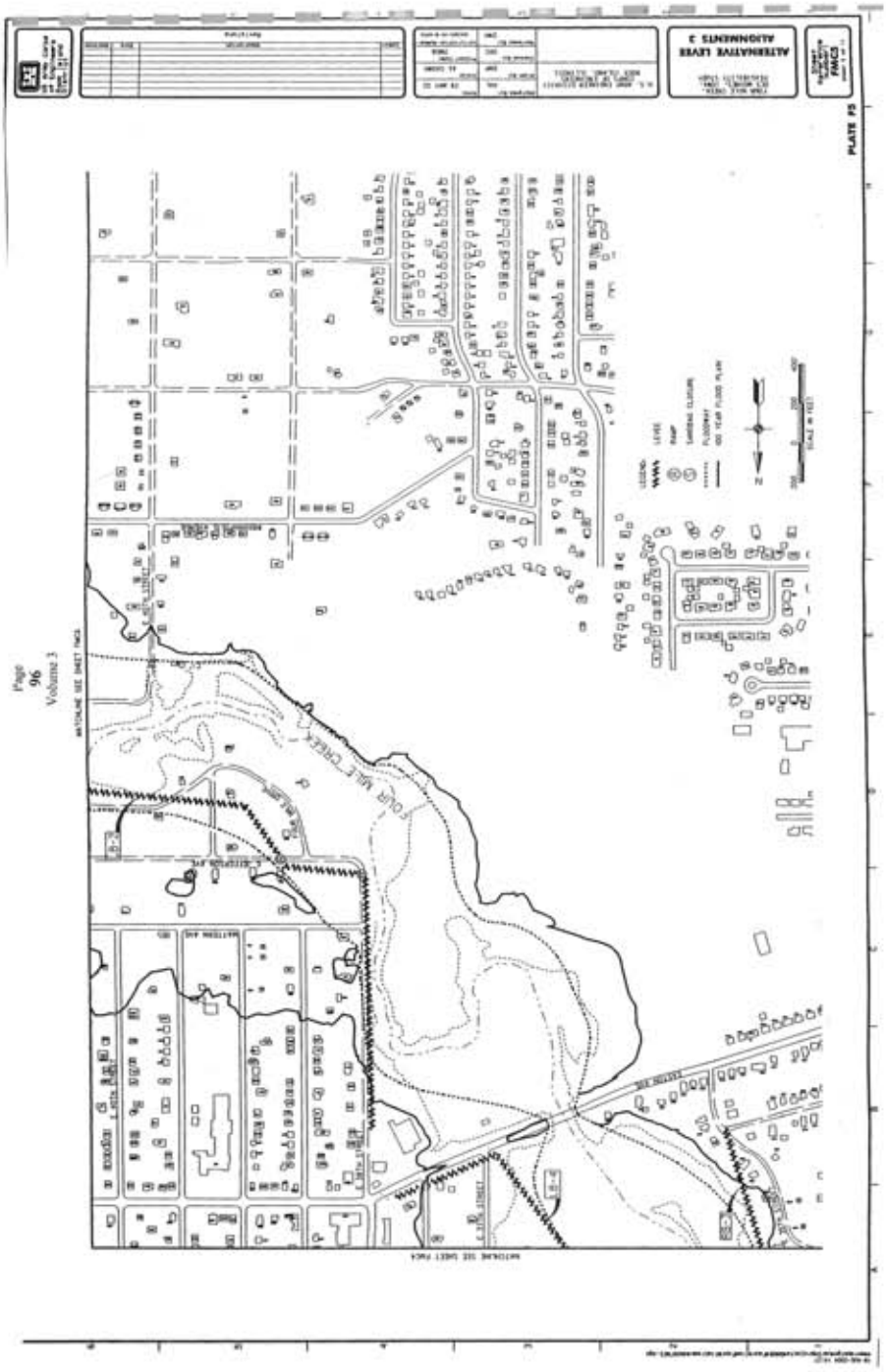
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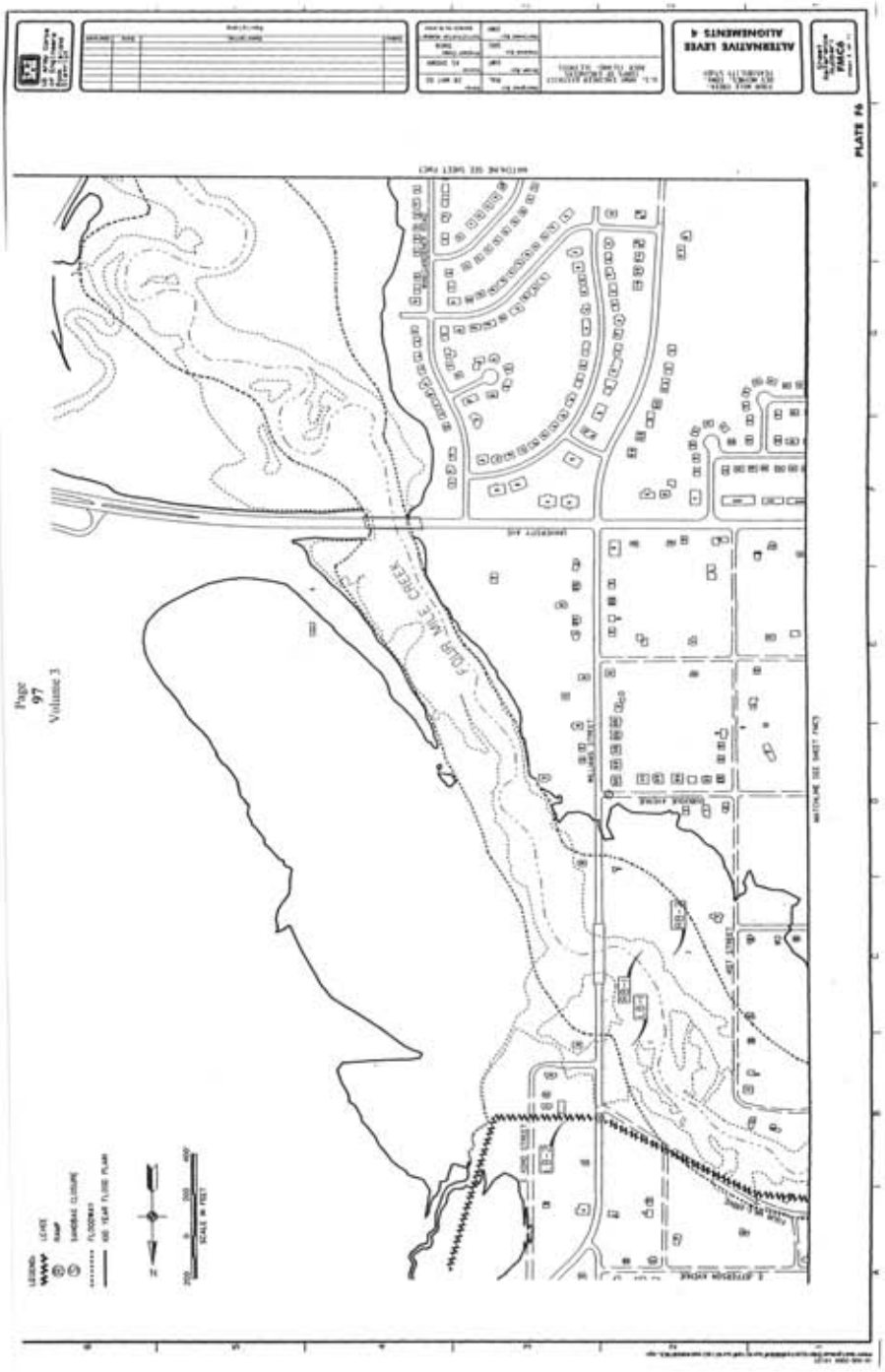
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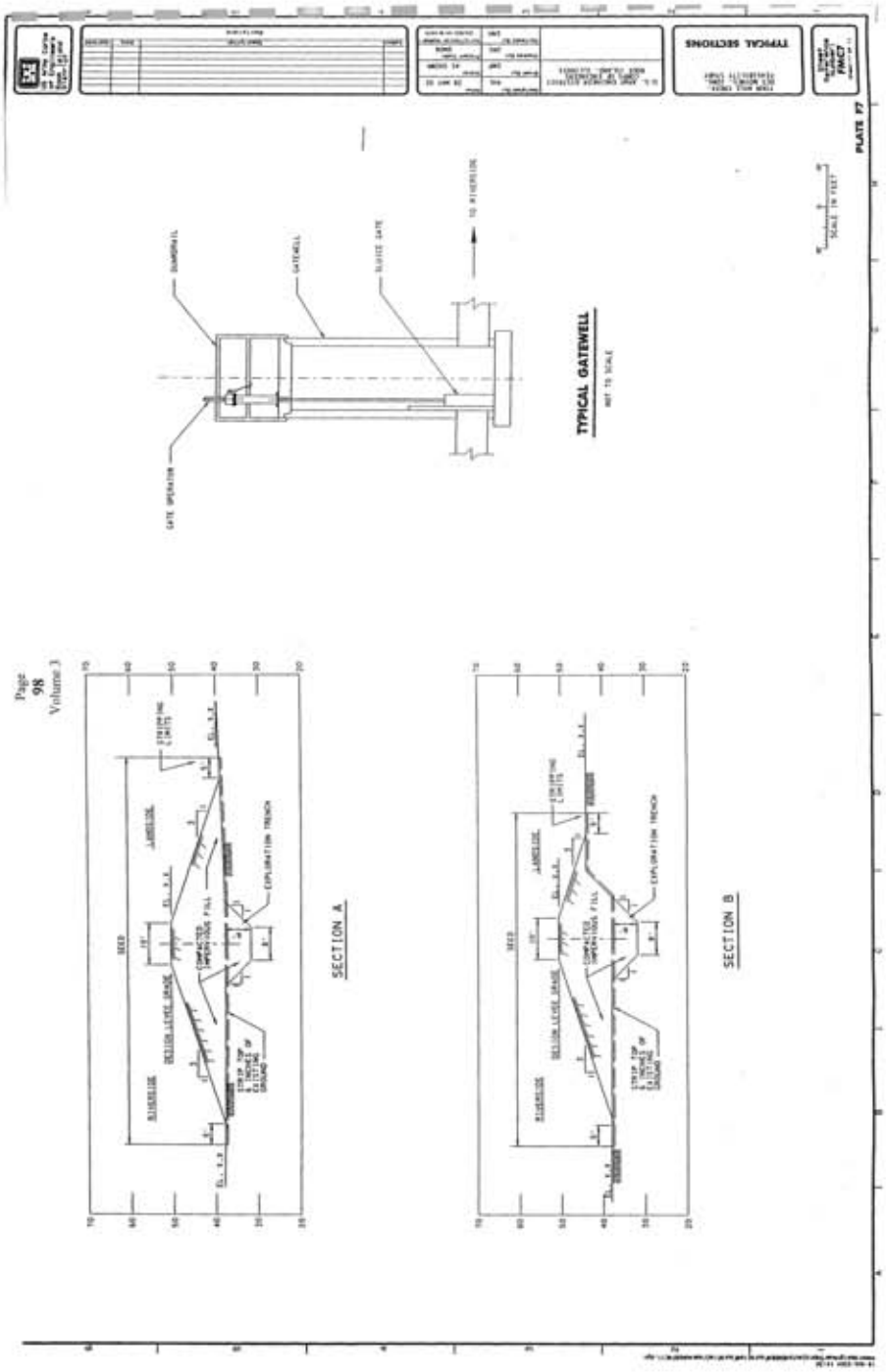
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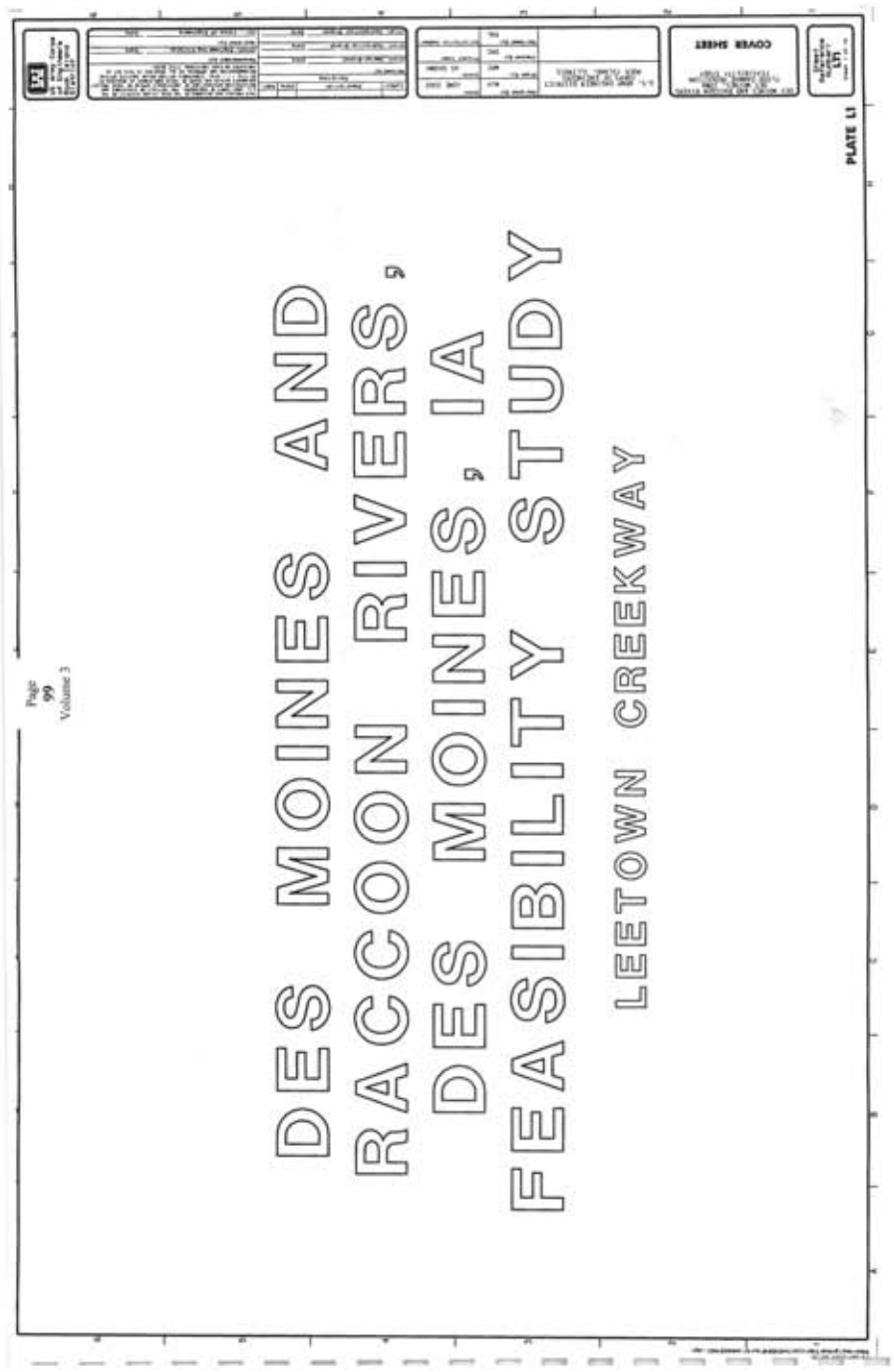
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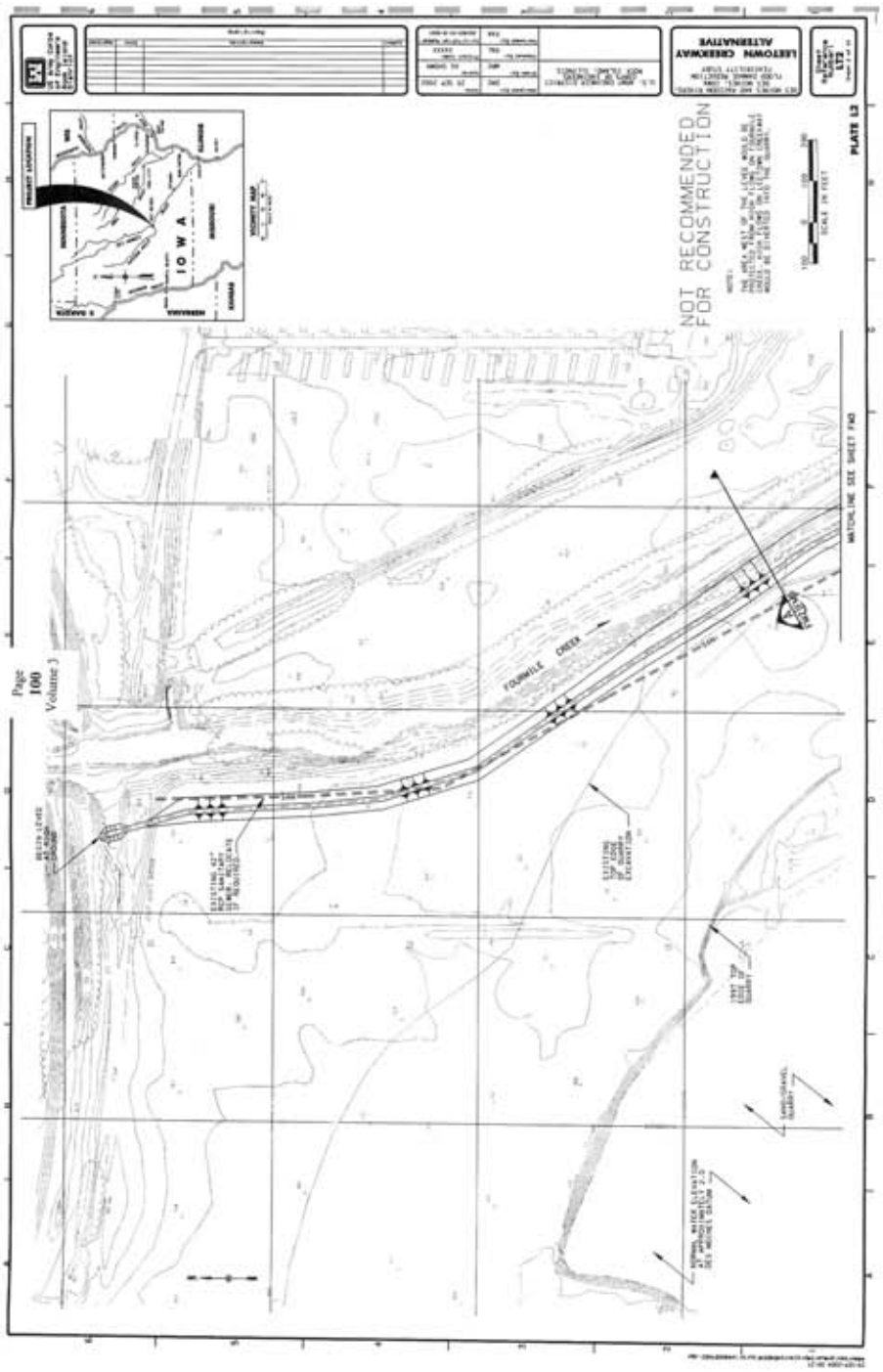
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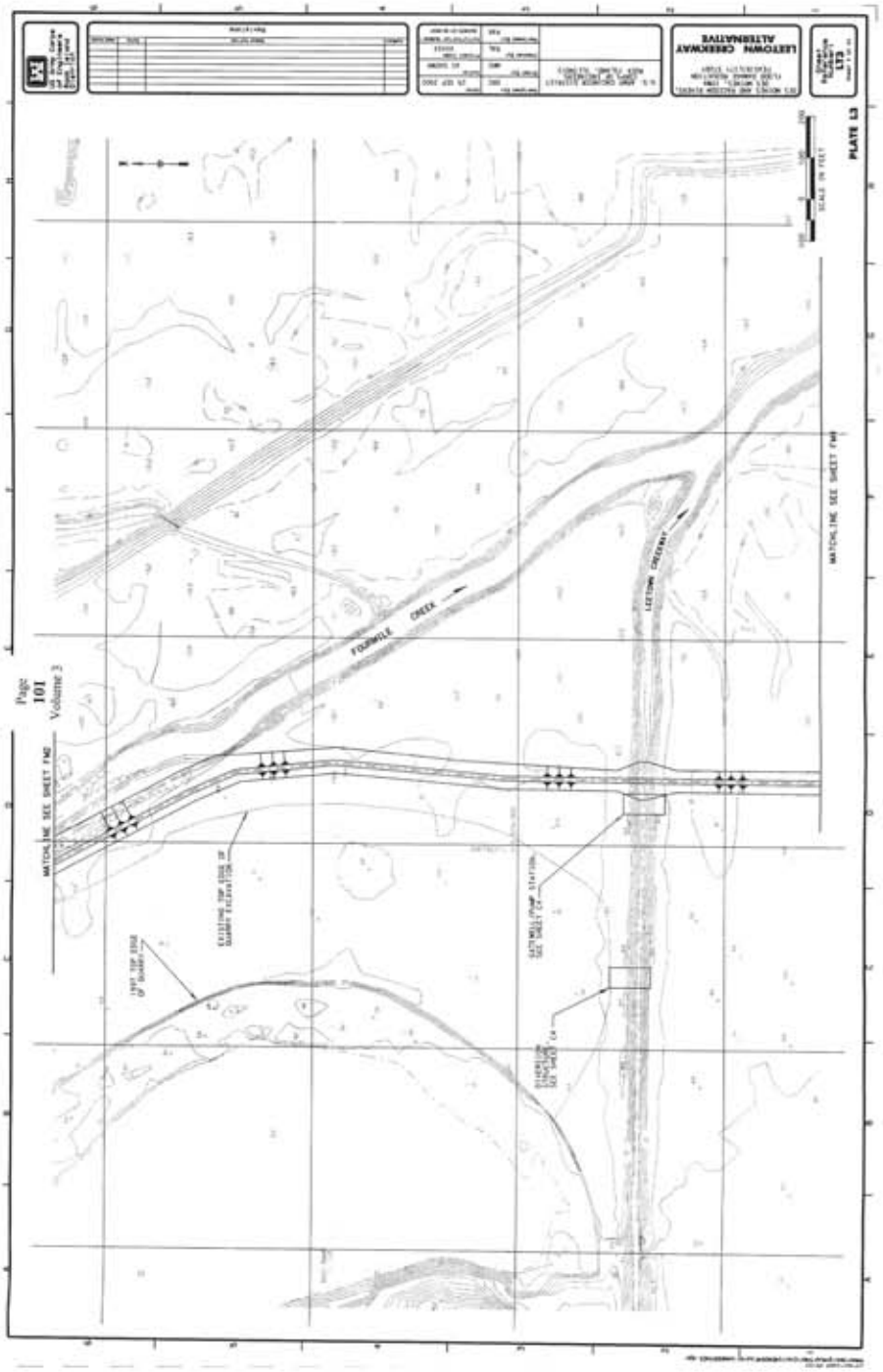

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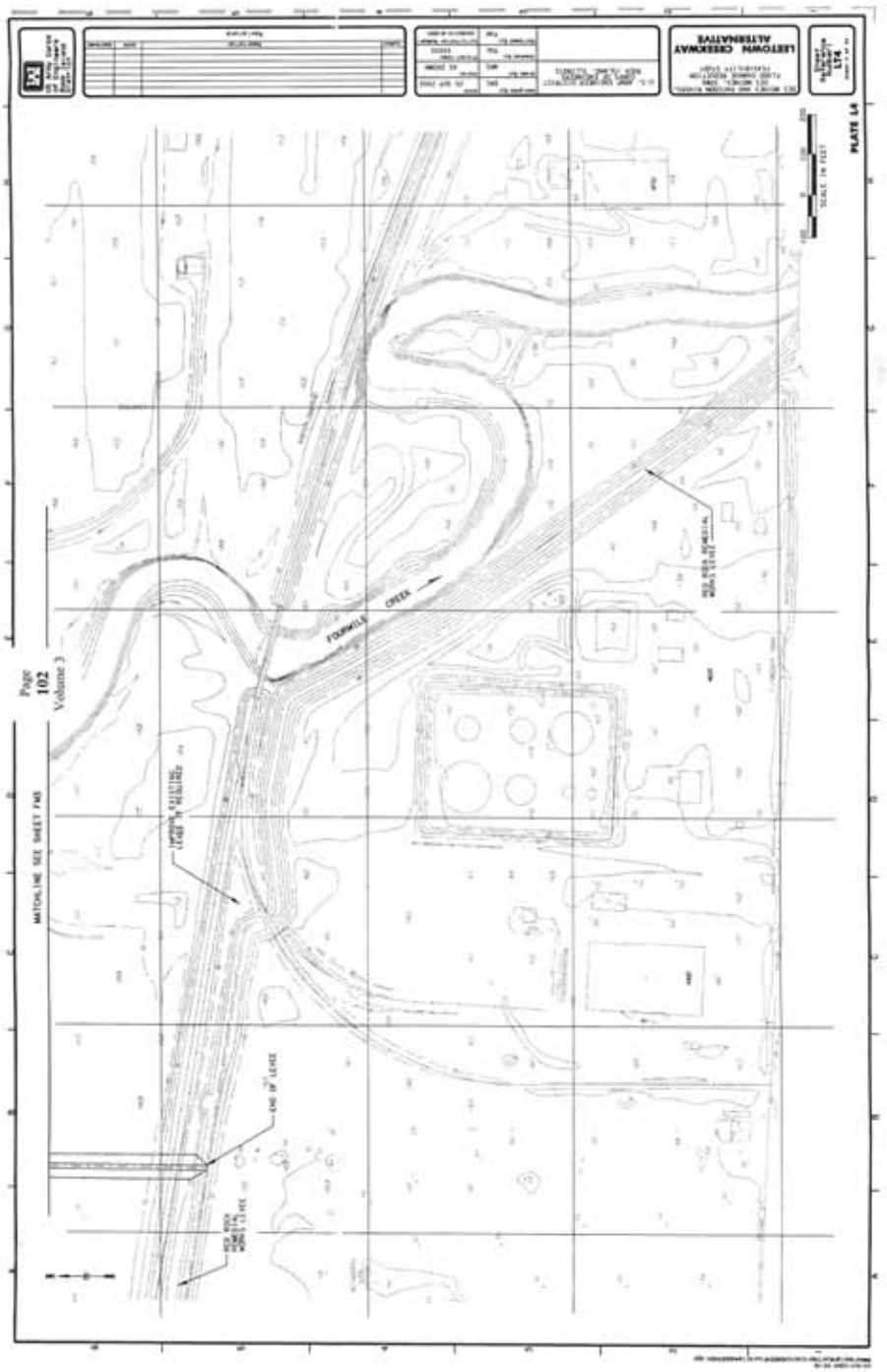
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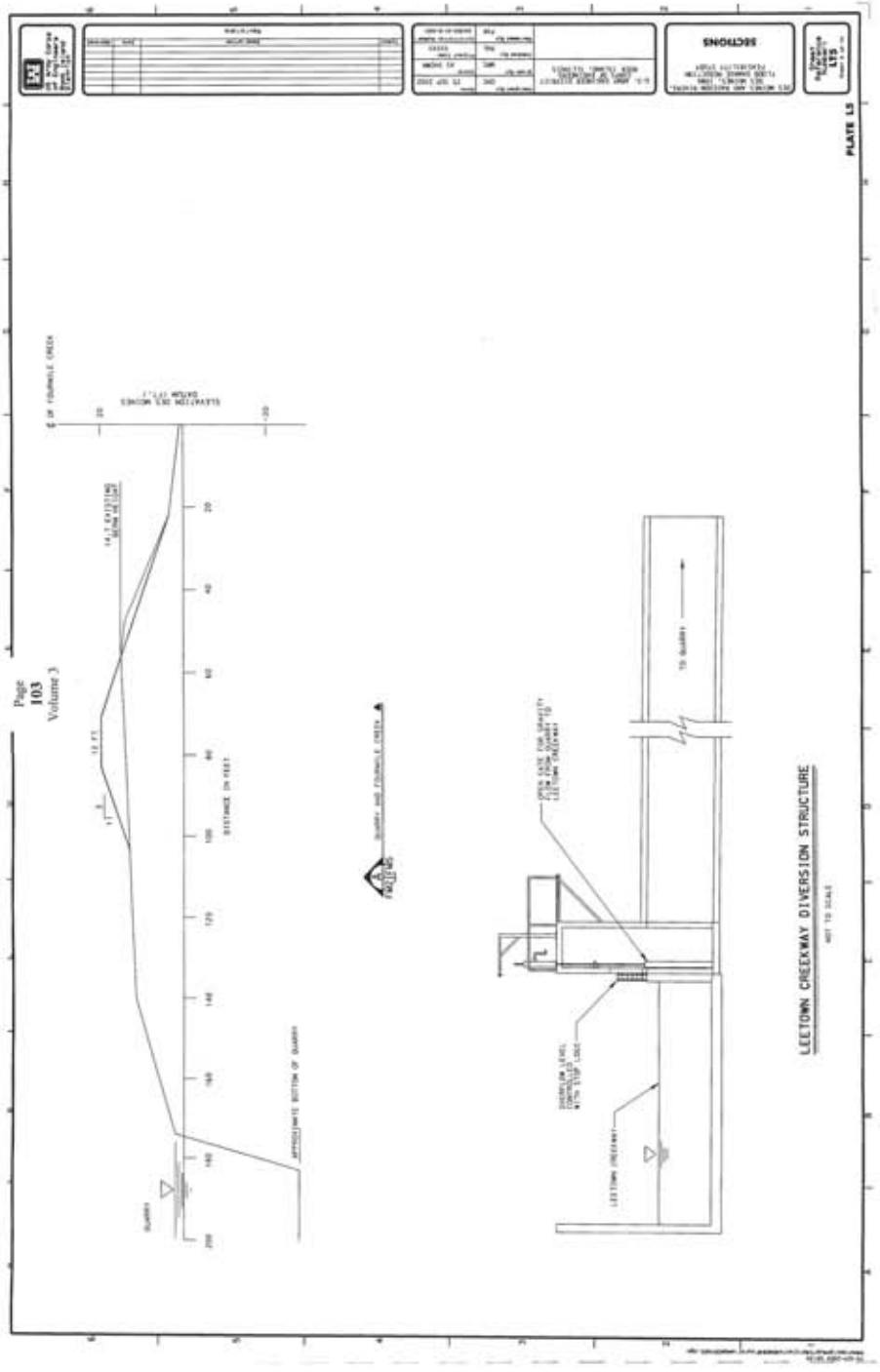
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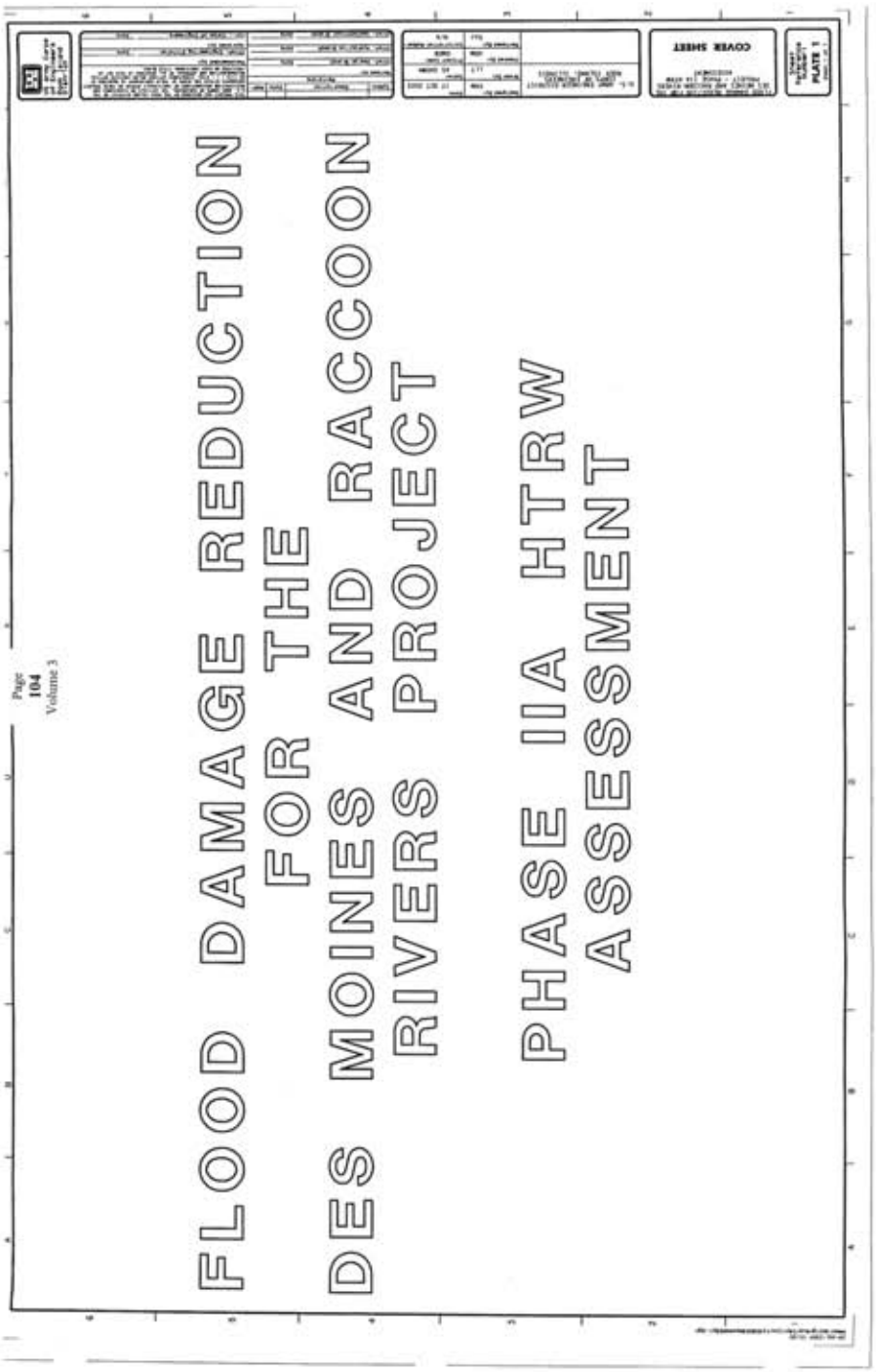
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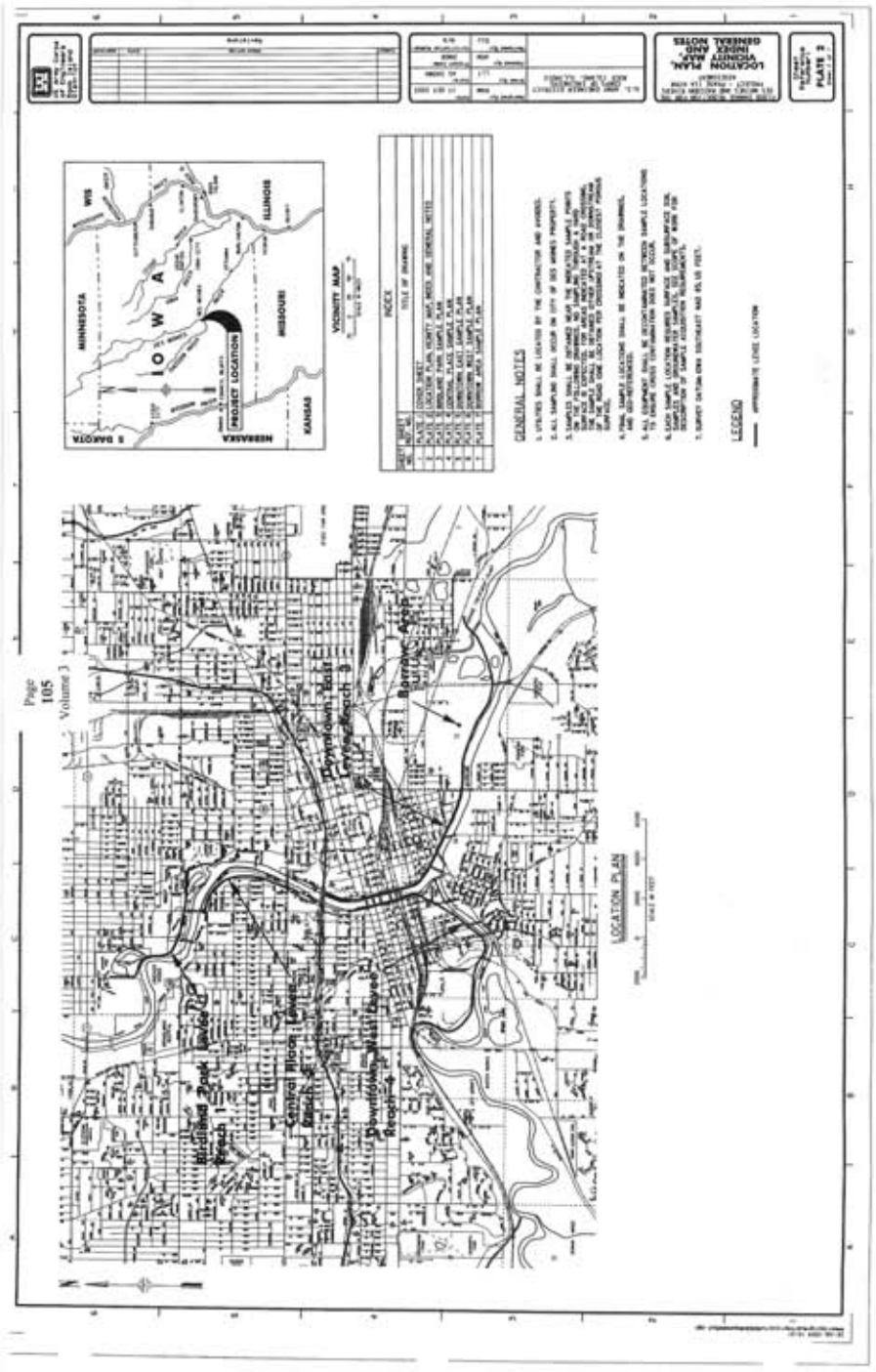
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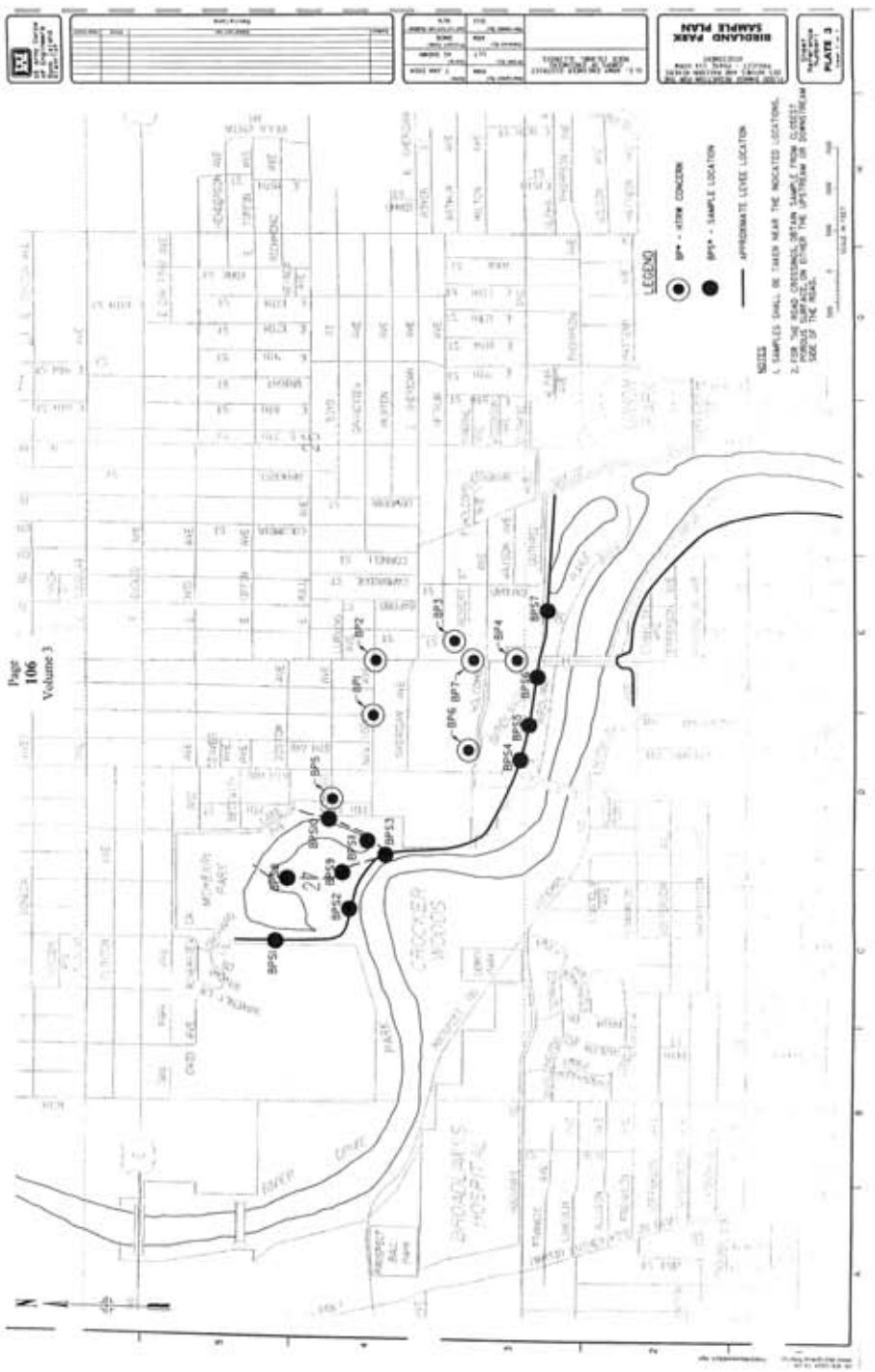
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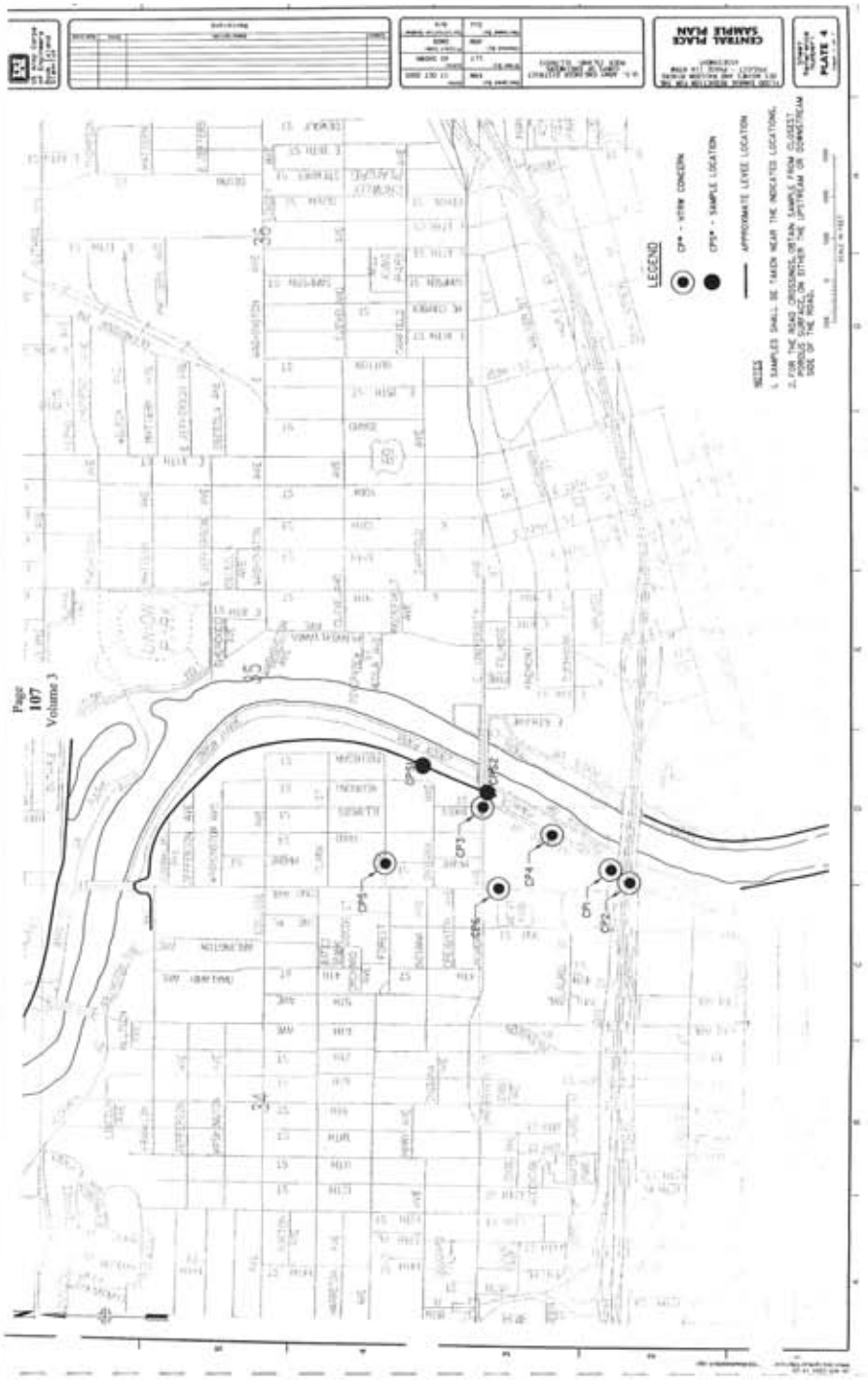
NOTES
1. SAMPLES SHALL BE TAKEN NEAR THE INDICATED LOCATIONS.
2. FOR THE ROAD CROSSINGS, OBTAIN SAMPLE FROM CLOSEST POROUS SURFACE, ON EITHER THE UPSTREAM OR DOWNSTREAM SIDE OF THE ROAD.
Page 106 Volume 3
BP1
BP2
BP3
BP4
BP5
BP6
BP7
BPS1
BPS2
BPS3
BPS4
BPS5
BPS6
BPS7
BPS8
BPS9
BPS10
BPS11
BPS12
BPS13
CROCKER WOODS
BROADLAWN'S HOSPITAL
RIVER LEVEE
PARK


CENTRAL PLACE
SAMPLE PLAN
PLATE 4
LEGEND
CP# - VIEW CONCERN
CP5* - SAMPLE LOCATION
APPROXIMATE LEVEE LOCATION
NOTES
1. SAMPLES SHALL BE TAKEN NEAR THE INDICATED LOCATIONS.
2. FOR THE DEEP CROSSINGS, OBTAIN SAMPLE FROM CLOSEST
ACCESSIBLE LOCATION EITHER UPSTREAM OR DOWNSTREAM
SIDE OF THE ROAD.
CP1
CP2
CP3
CP4
CP5
CP6
Page
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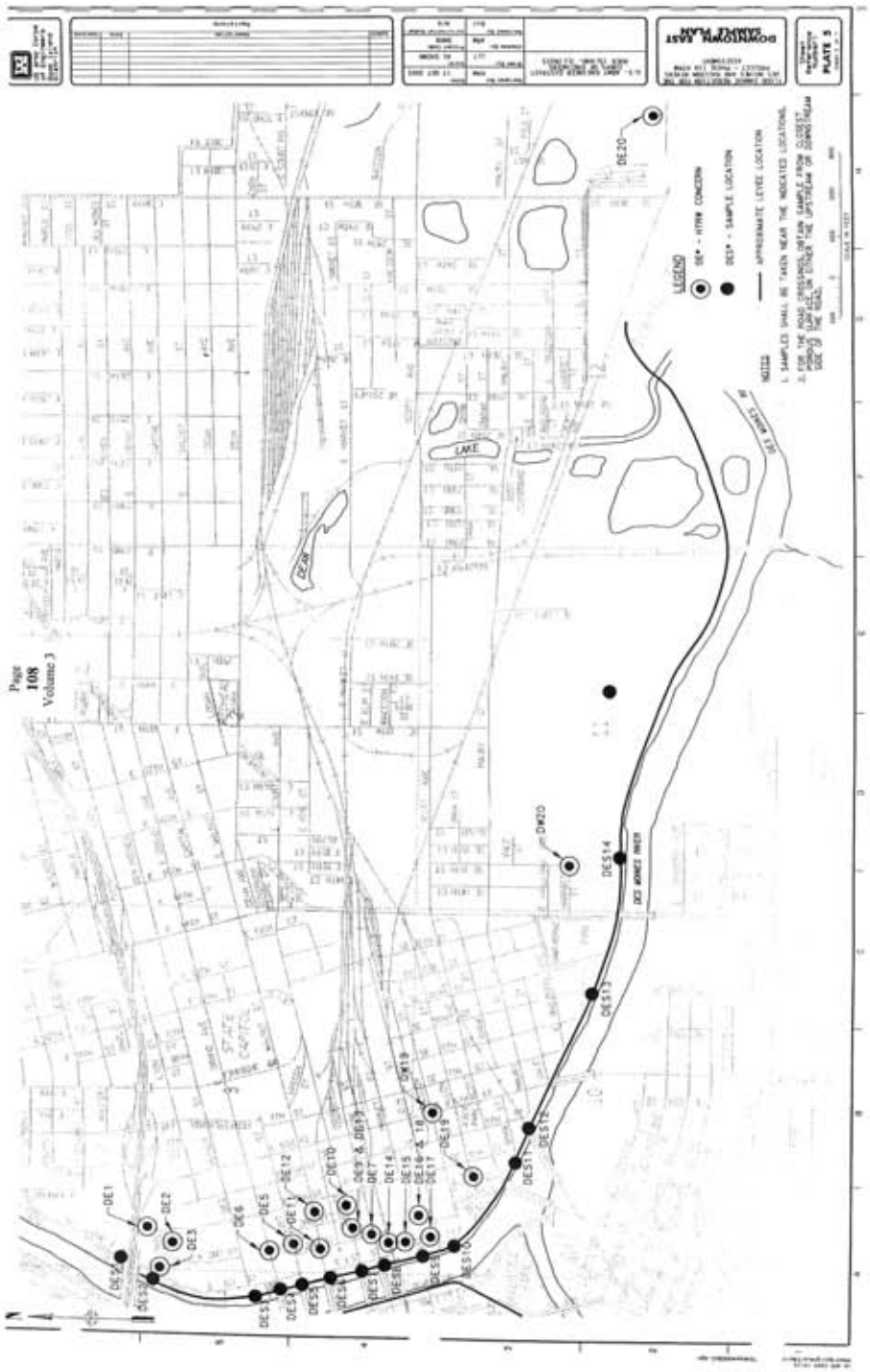
Volume 3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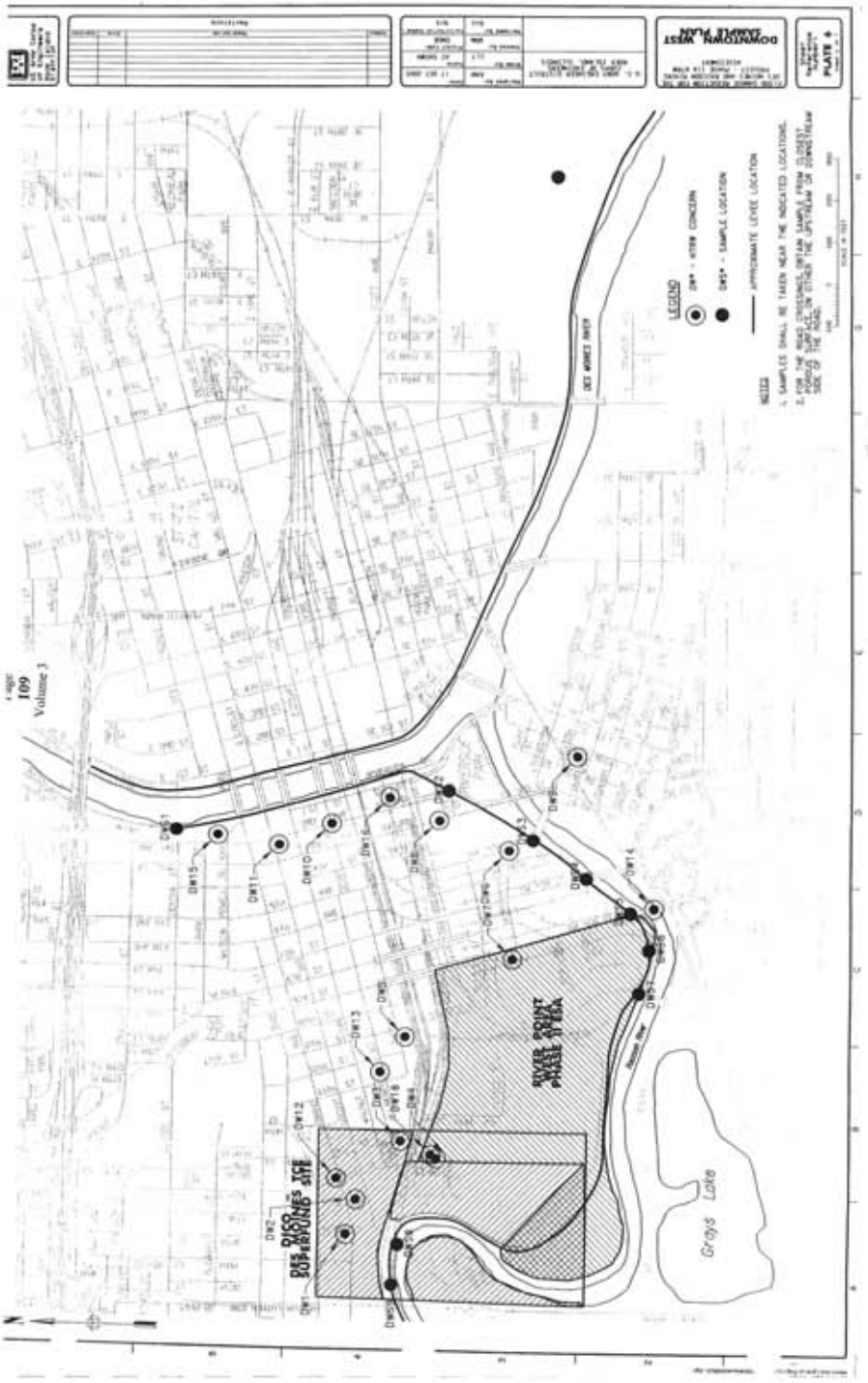
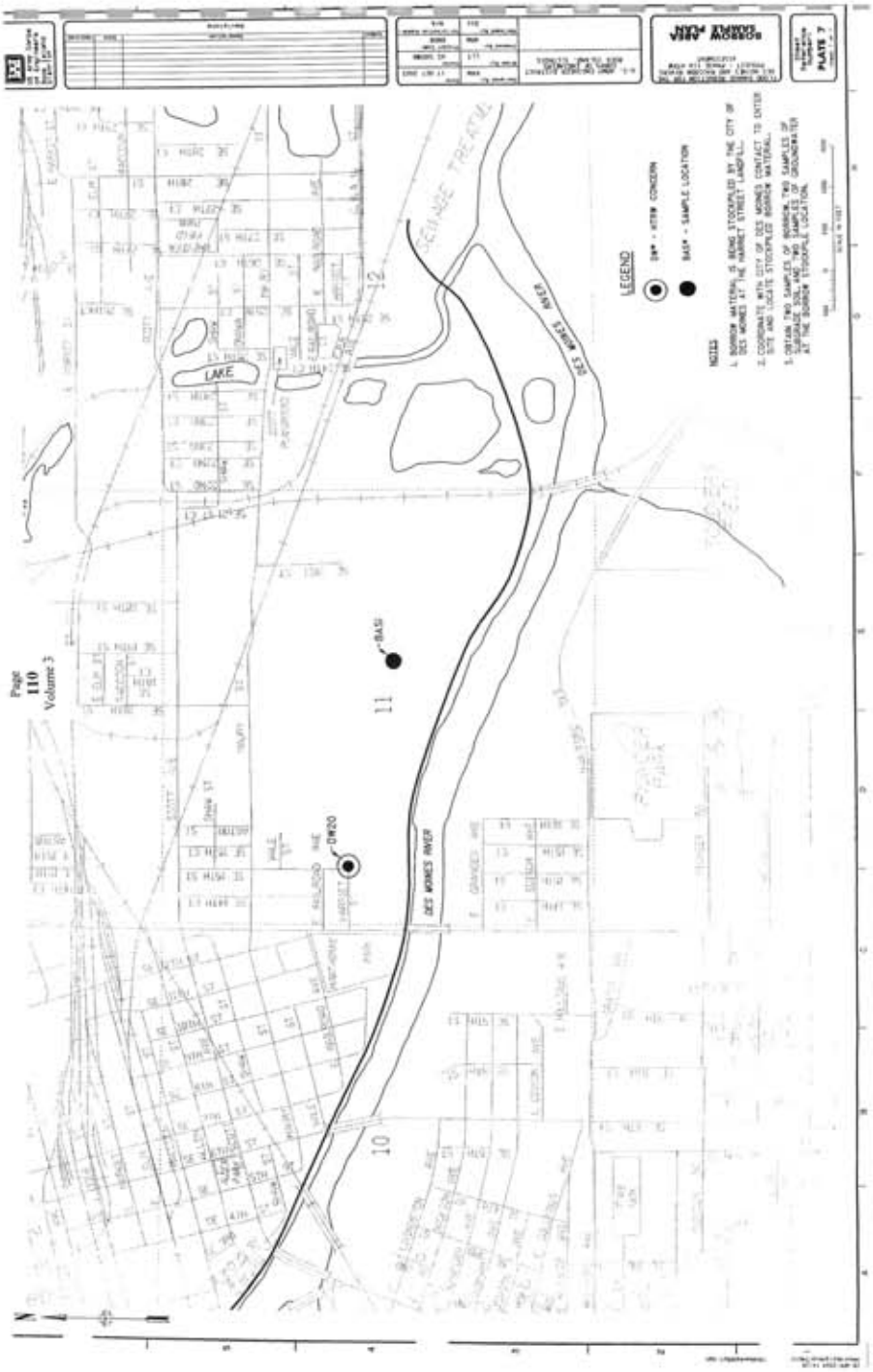
108
Volume 3
LEGEND
DE* - HTRW CONCERN
DES* - SAMPLE LOCATION
APPROXIMATE LEVEE LOCATION
NOTES
1. SAMPLES SHALL BE TAKEN NEAR THE INDICATED LOCATIONS.
2. FOR THE ROAD CROSSINGS, OBTAIN SAMPLE FROM CLOSEST PONDUS SURFACE ON EITHER THE UPSTREAM OR DOWNSTREAM SIDE OF THE ROAD.
DOWNTOWN EAST
SAMPLE PLAN
PLATE 5
DE1
DE2
DE3
DE5
DE6
DE7
DE10
DE11
DE12
DE14
DE15
DE16 & 18
DE17
DE19
DE20
DW19
DW20
DES10
DES11
DES12
DES13
DES14
DES WOMES RIVER
DEAR
LAKE


DOWNTOWN WEST SAMPLE PLAN
PLATE 4
LEGEND
DW* - HTRW CONCERN
DWS* - SAMPLE LOCATION
APPROXIMATE LEVEE LOCATION
NOTES
1. SAMPLES SHALL BE TAKEN NEAR THE INDICATED LOCATIONS.
2. FOR THE ROAD CROSSINGS, OBTAIN SAMPLE FROM CLOSEST POROUS SURFACE ON OTHER THE UPSTREAM OR DOWNSTREAM SIDE OF THE ROAD.
DES MOINES RIVER
RIVER POINT WEST AREA PHASE II EEA
DES MOINES TCE SUPERFUND SITE
Grays Lake
Volume 3
109


LEGEND
DW* - KTRW CONCERN
BAS* - SAMPLE LOCATION
NOTES
1. BORROW MATERIAL IS BEING STOCKPILED BY THE CITY OF DES MOINES AT THE HARRIET STREET LANDFILL.
2. COORDINATE WITH CITY OF DES MOINES CONTACT TO ENTER SITE AND LOCATE STOCKPILED BORROW MATERIAL.
3. OBTAIN TWO SAMPLES OF BORROW, TWO SAMPLES OF SUBGRADE SOIL AND TWO SAMPLES OF GROUNDWATER AT THE BORROW STOCKPILE LOCATION.
LAKE
DES MOINES RIVER
BAS1
DW20
11
10
12
Page
110
Volume 3
PLATE 7

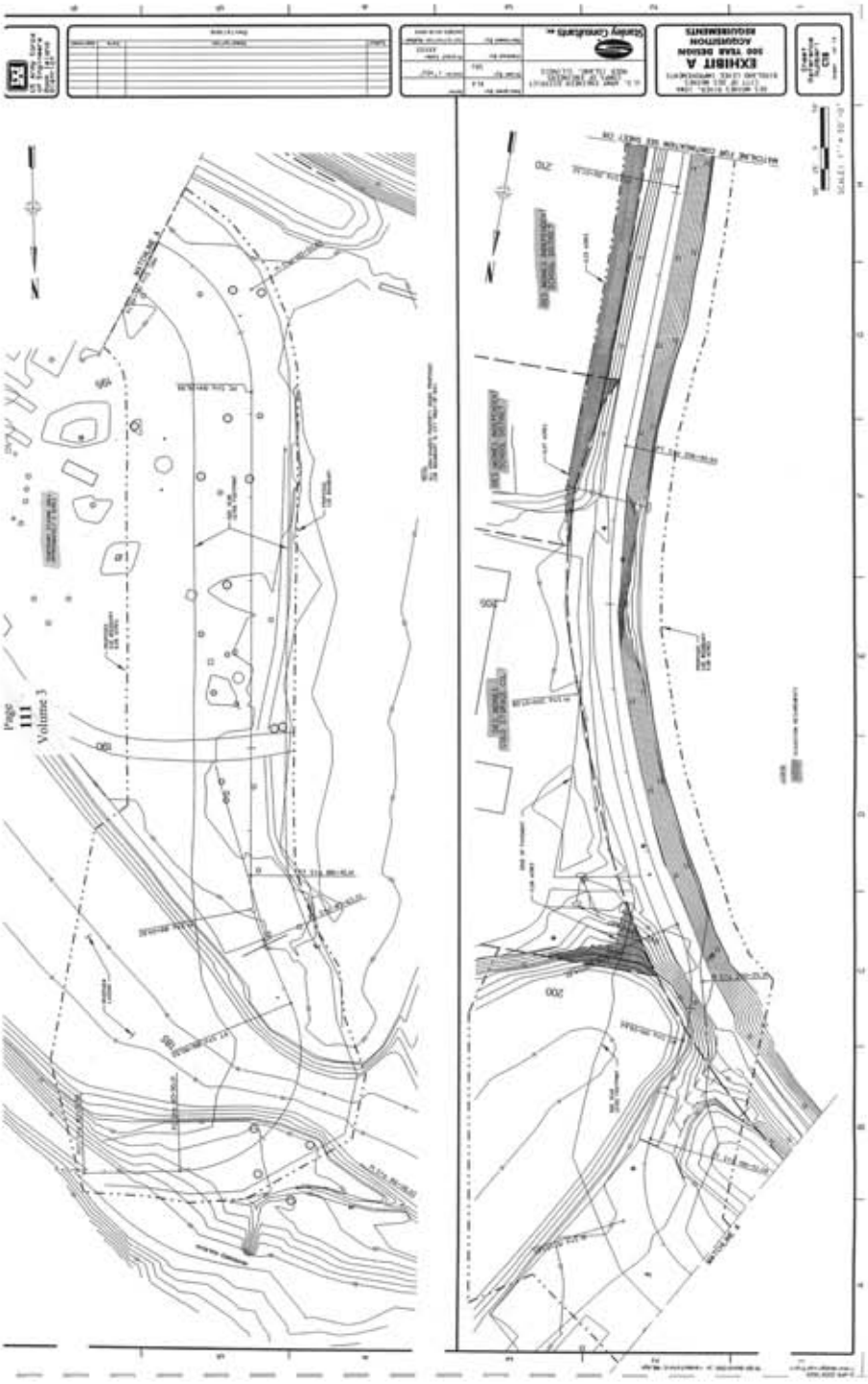


EXHIBIT A
Page
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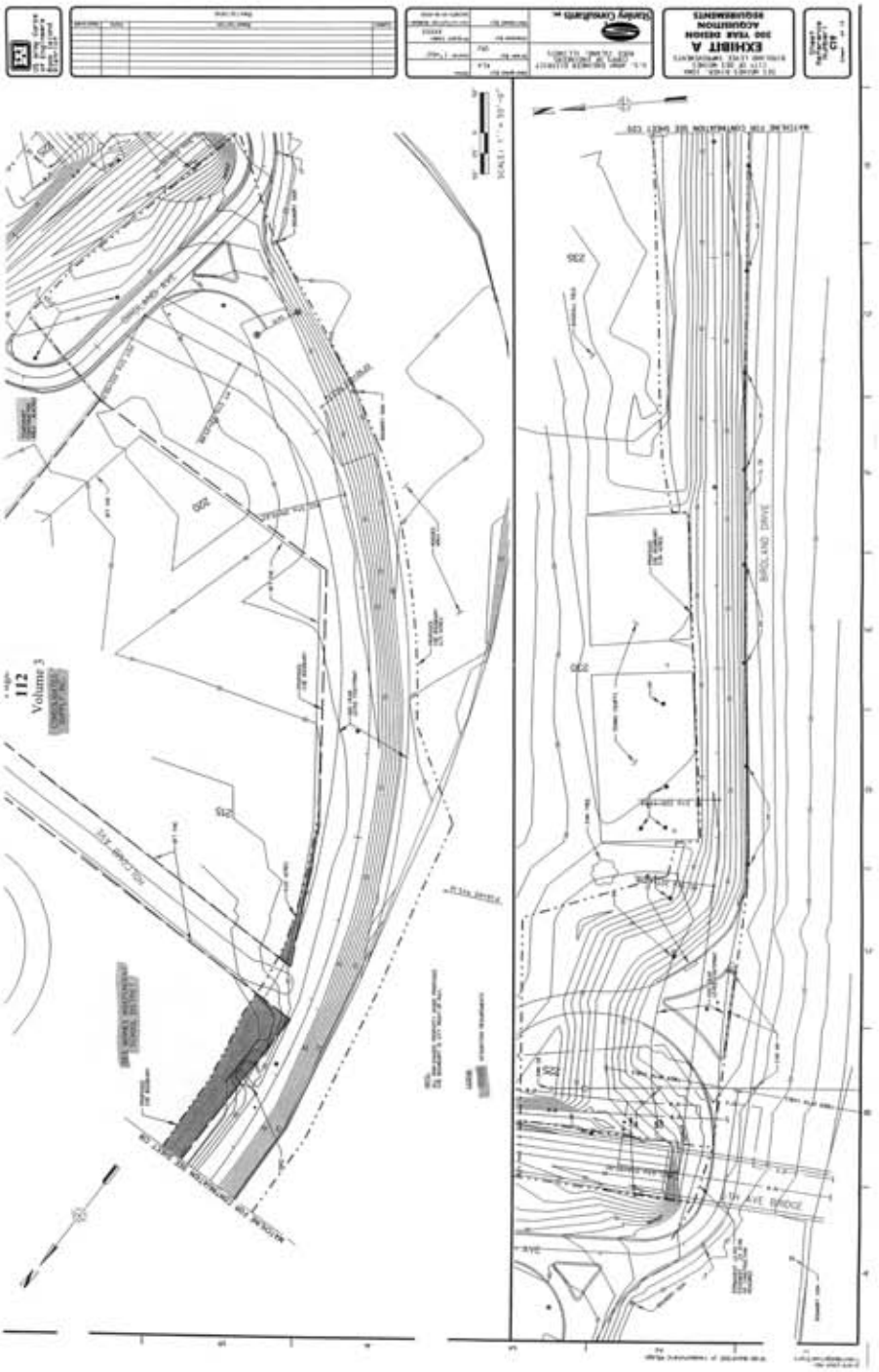
EXHIBIT A
300 YEAR DESIGN
ACQUISITION
REQUIREMENTS
Stanley Consultants
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Volume 3
BROLAND DRIVE
UV AVE BRIDGE

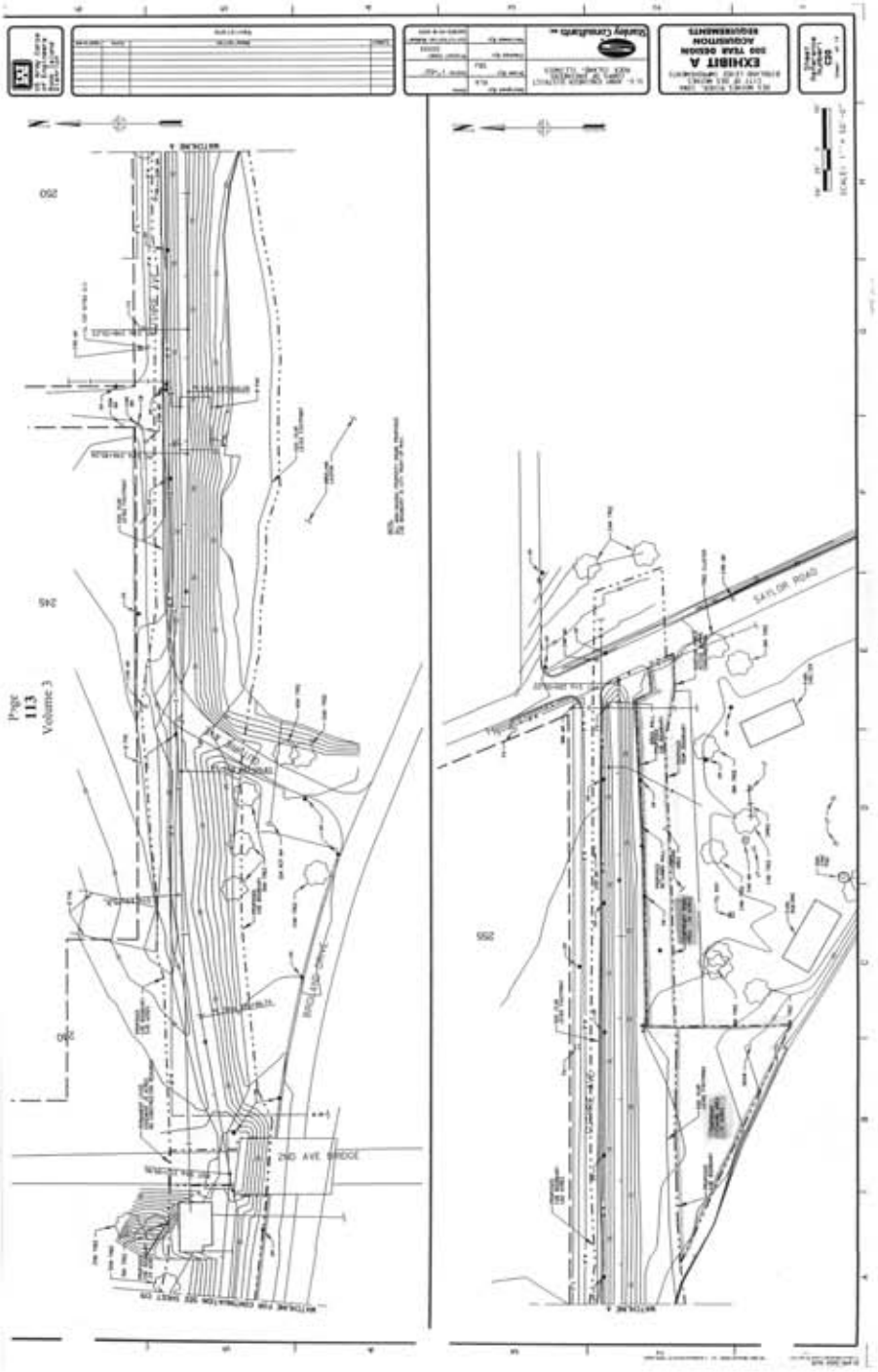
EXHIBIT A
SAYLOR ROAD
2ND AVE BRIDGE
Page
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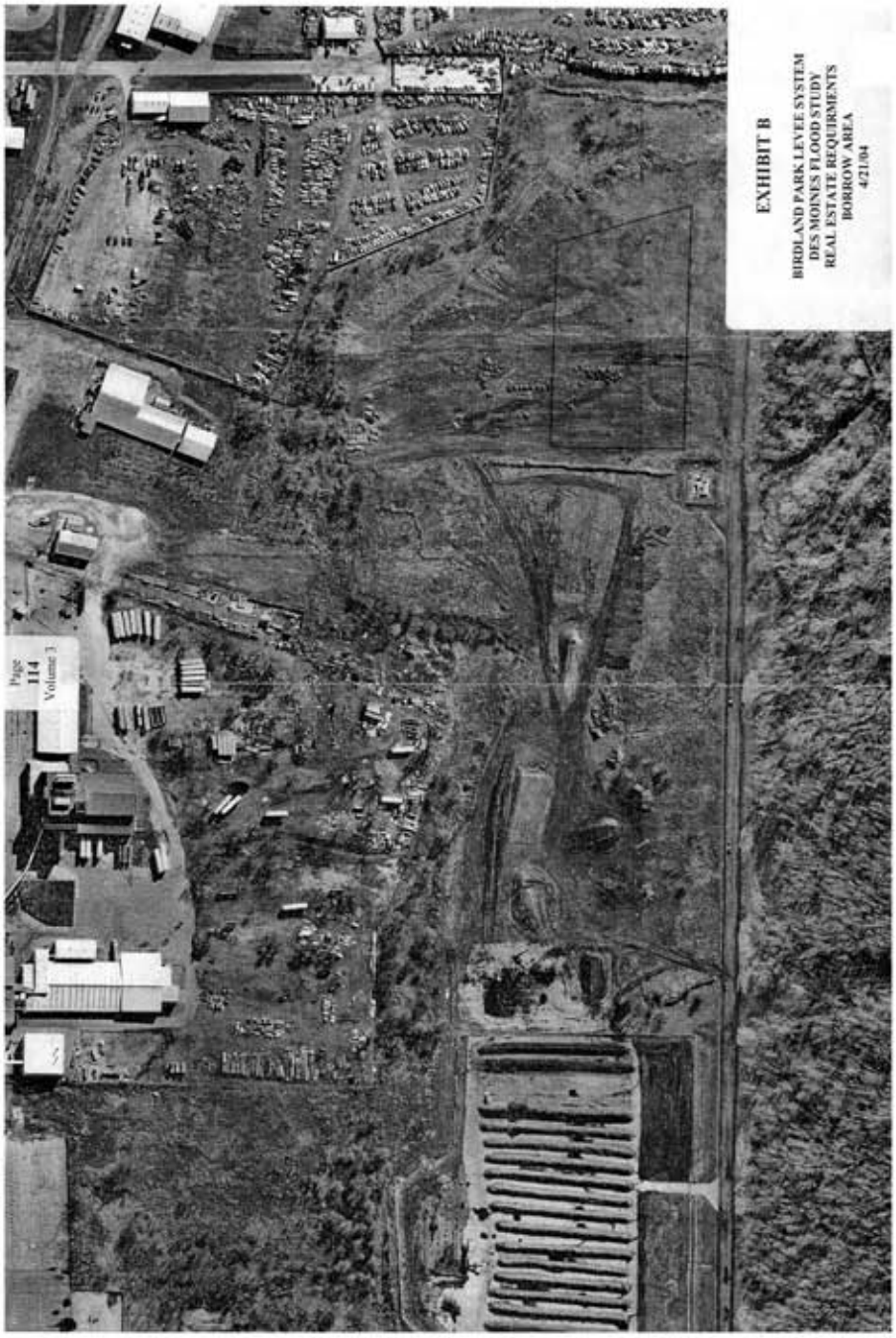
EXHIBIT B
BIRDLAND PARK LEVEE SYSTEM
DES MOINES FLOOD STUDY
REAL ESTATE REQUIRMENTS
BORROW AREA
4/21/04
Page
114
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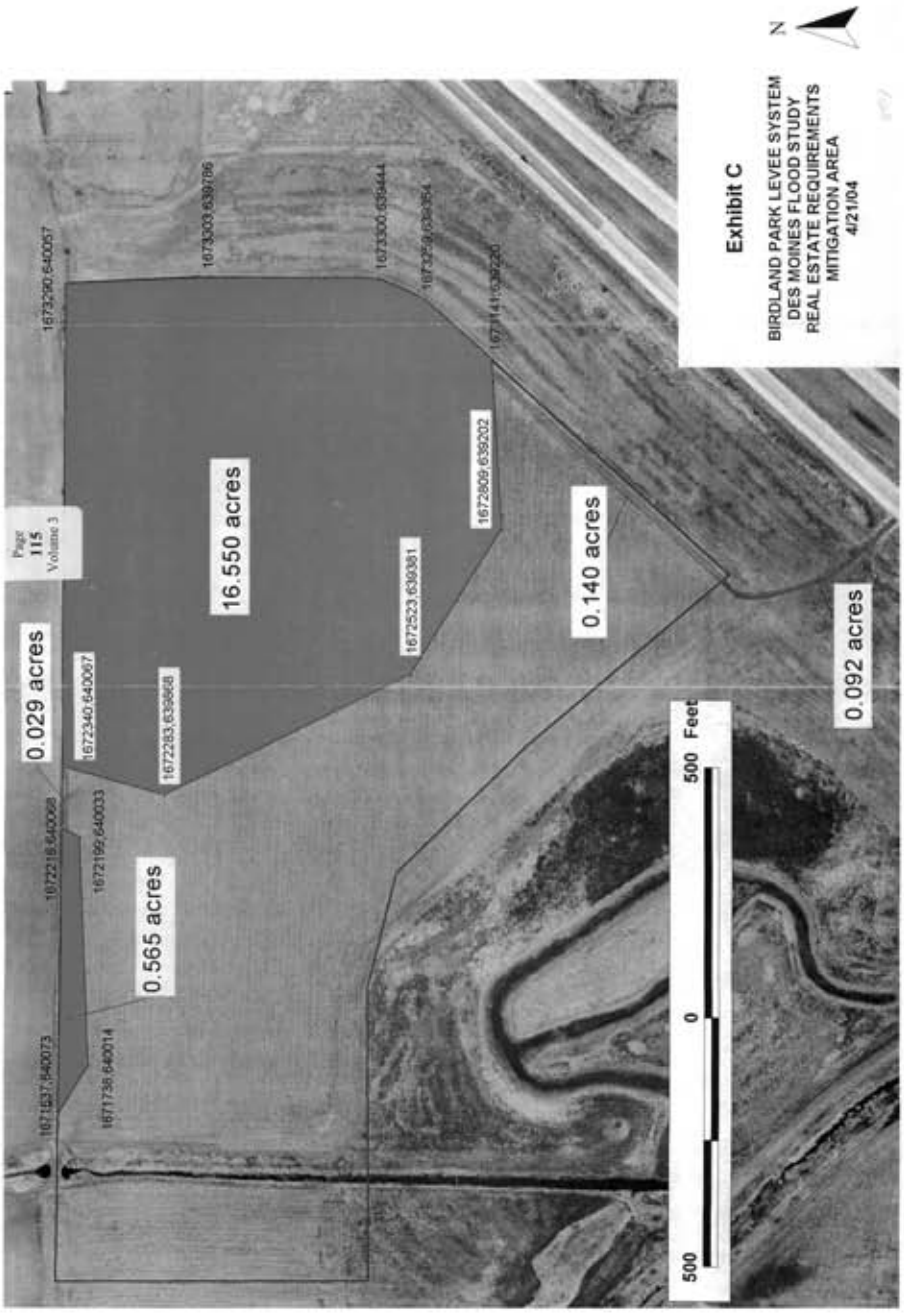
Exhibit C
BIRDLAND PARK LEVEE SYSTEM
DES MOINES FLOOD STUDY
REAL ESTATE REQUIREMENTS
MITIGATION AREA
4/21/04
N
0.029 acres
16.550 acres
0.565 acres
0.140 acres
0.092 acres
Page 115 Volume 3
1671637,640073
1672218,640068
1672199,640033
1671738,640014
1672340,640067
1672283,639868
1673290,640057
1673303,639766
1673300,639444
1673259,639364
1672523,639381
1672809,639202
500 0 500 Feet

Easement Levee
Fee Mitigation
RIPRAP
Page 116 Volume 3
EXHIBIT A
CENTRAL PLACE LEVEE SYSTEM
DES MOINES FLOOD STUDY
REAL ESTATE REQUIREMENTS
4/21/04

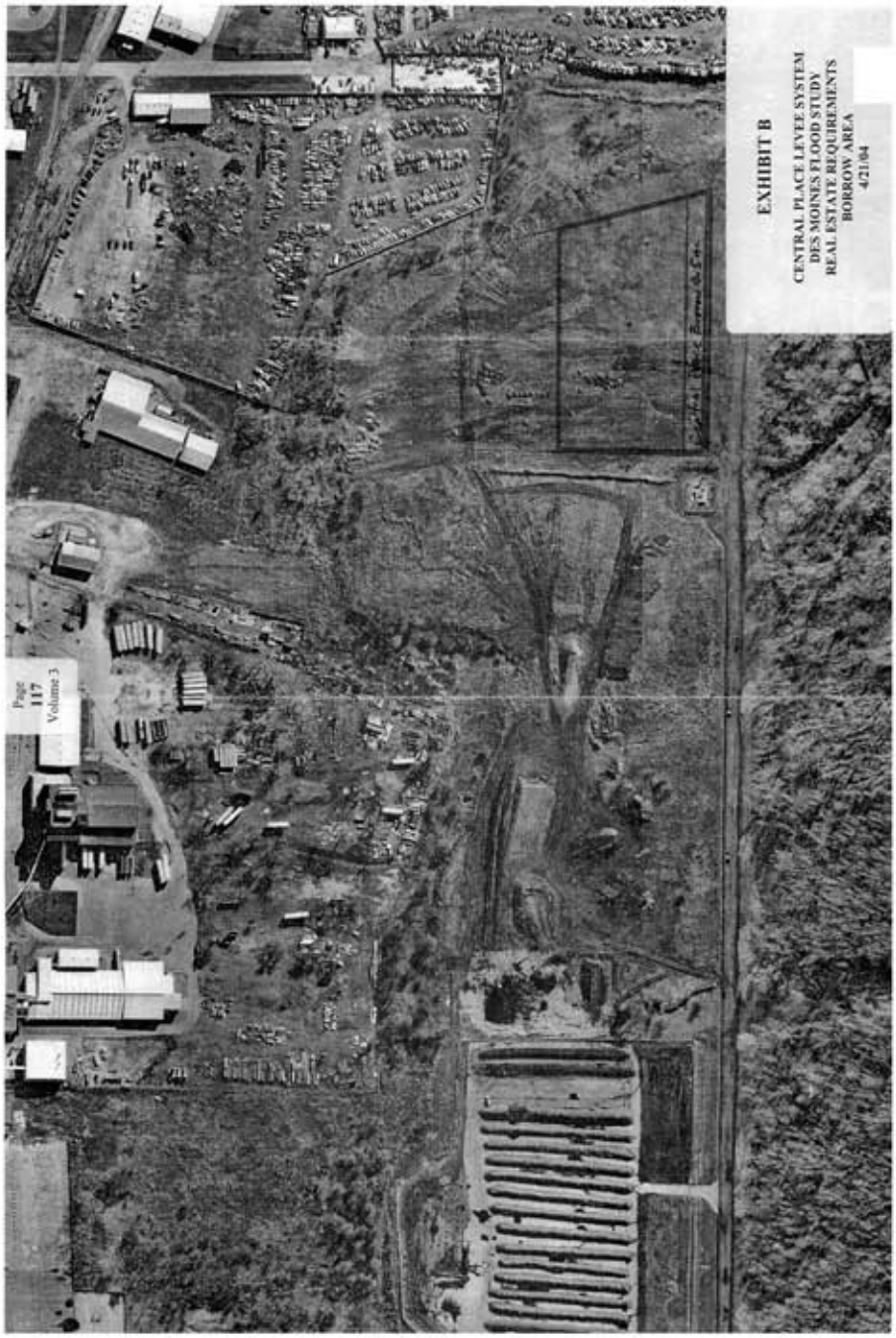
EXHIBIT B
CENTRAL PLACE LEVEE SYSTEM
DES MOINES FLOOD STUDY
REAL ESTATE REQUIREMENTS
BORROW AREA
4/21/04
Page
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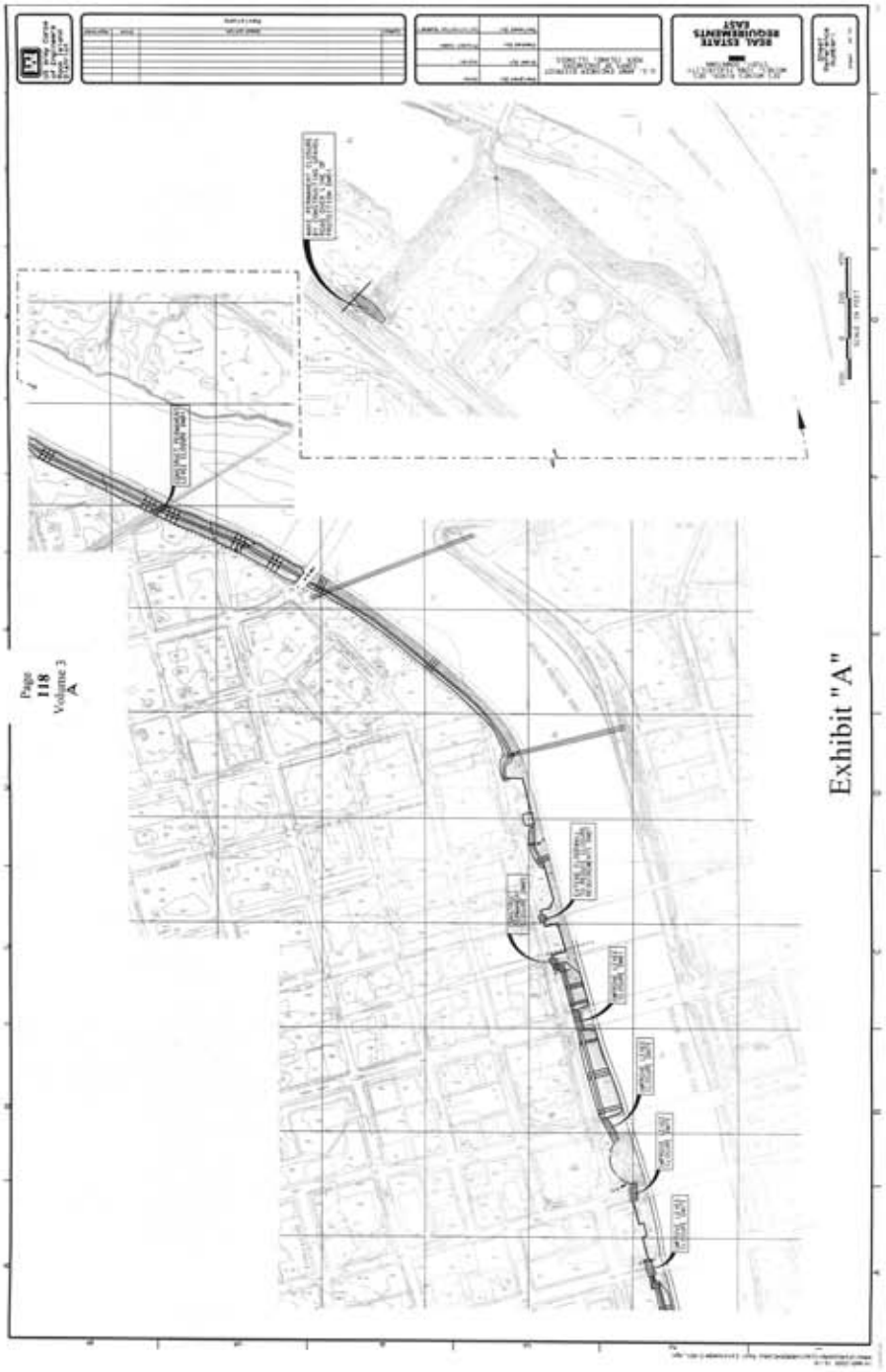
REAL ESTATE REQUIREMENTS EAST
Exhibit "A"
Page 118
Volume 3
A

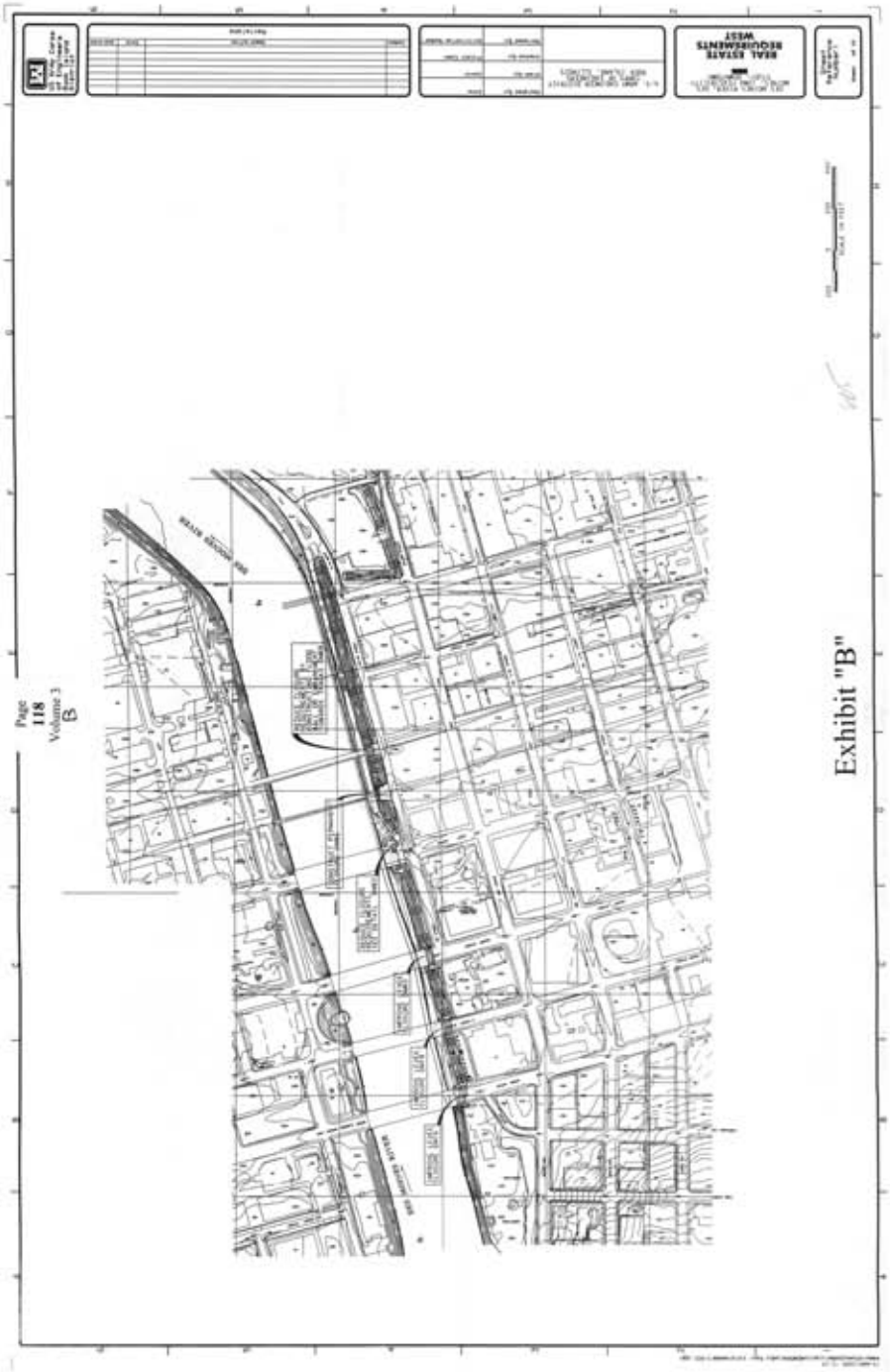
Exhibit "B"
Page
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Volume 3
B

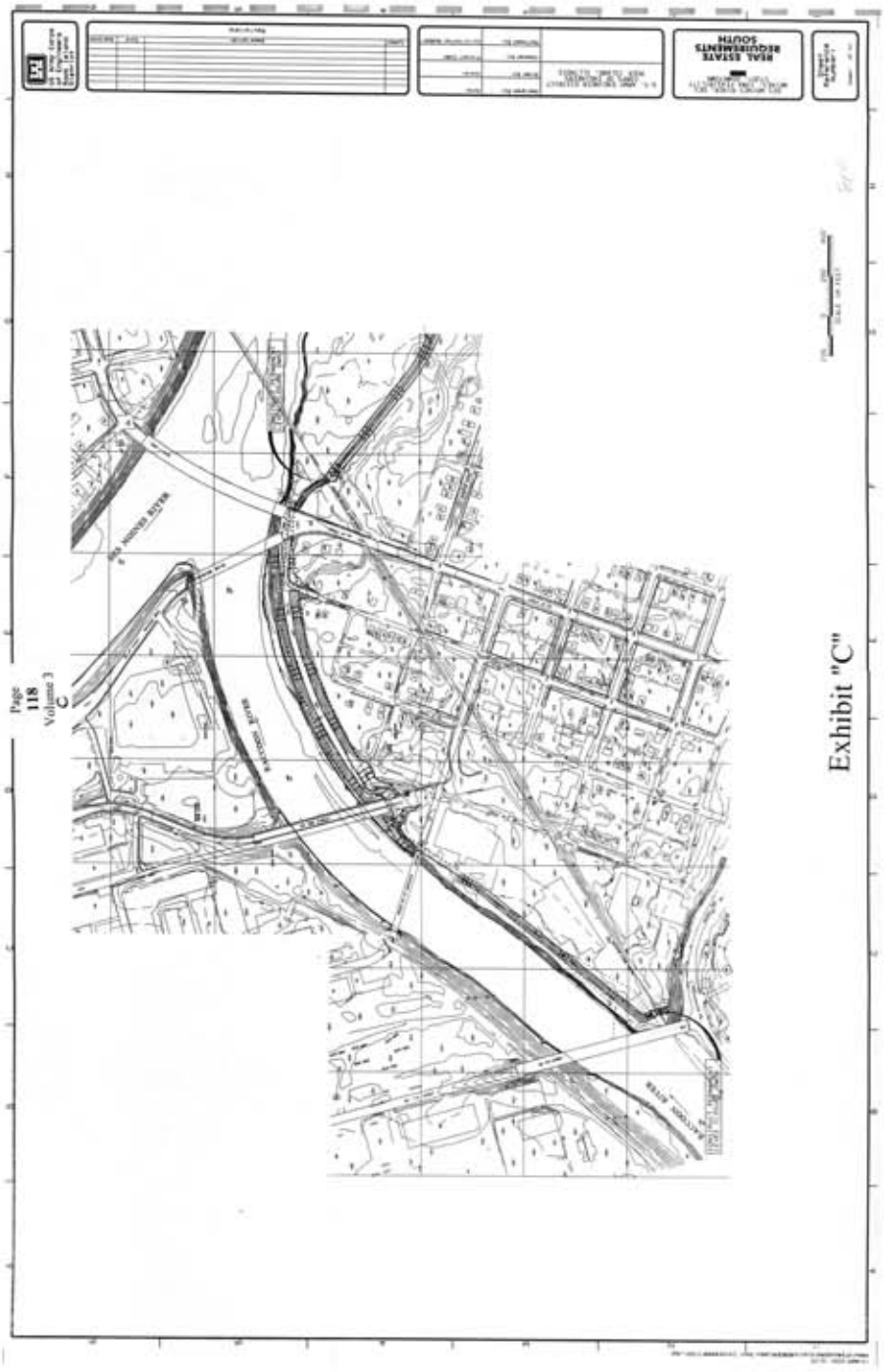
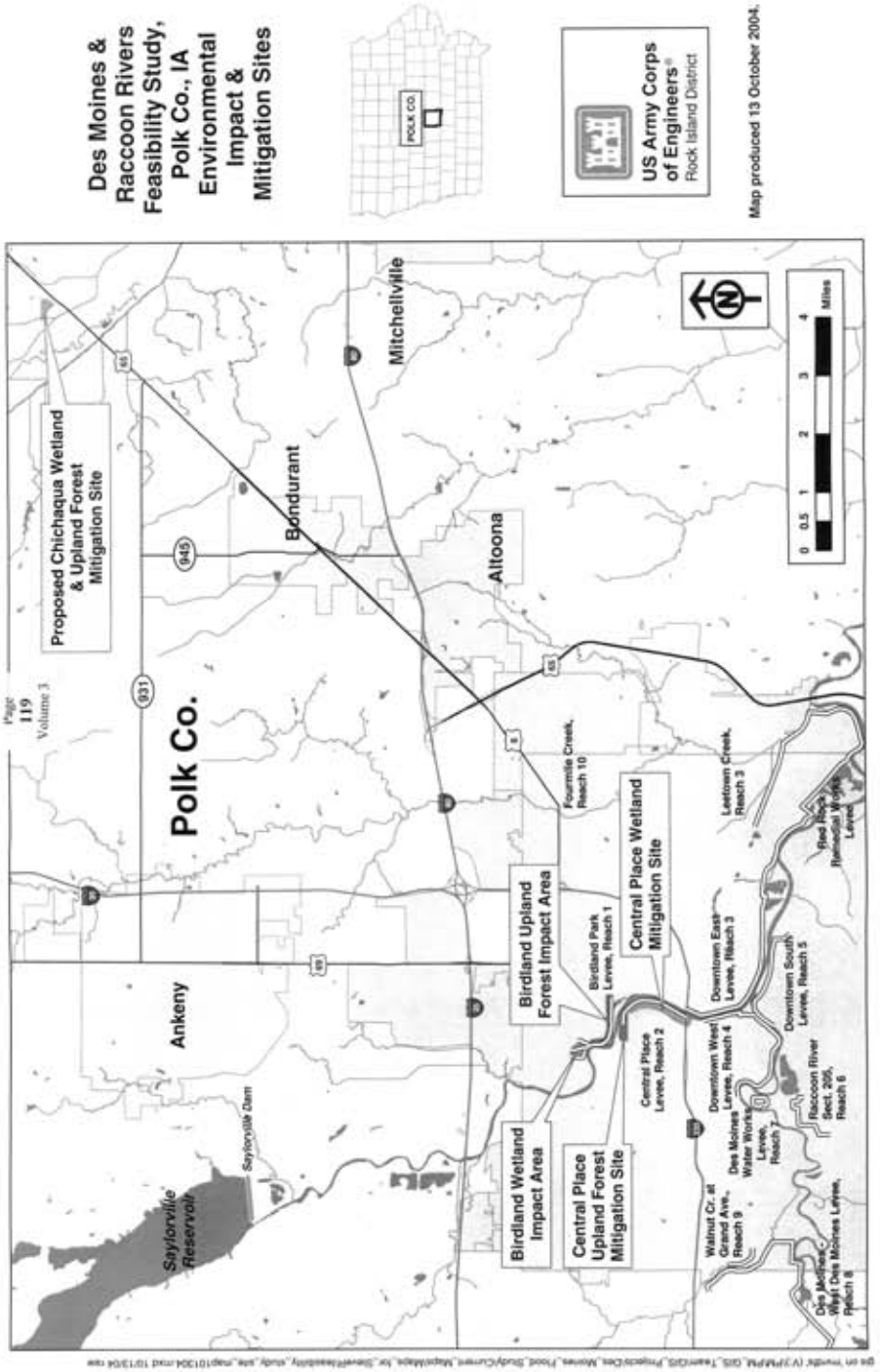
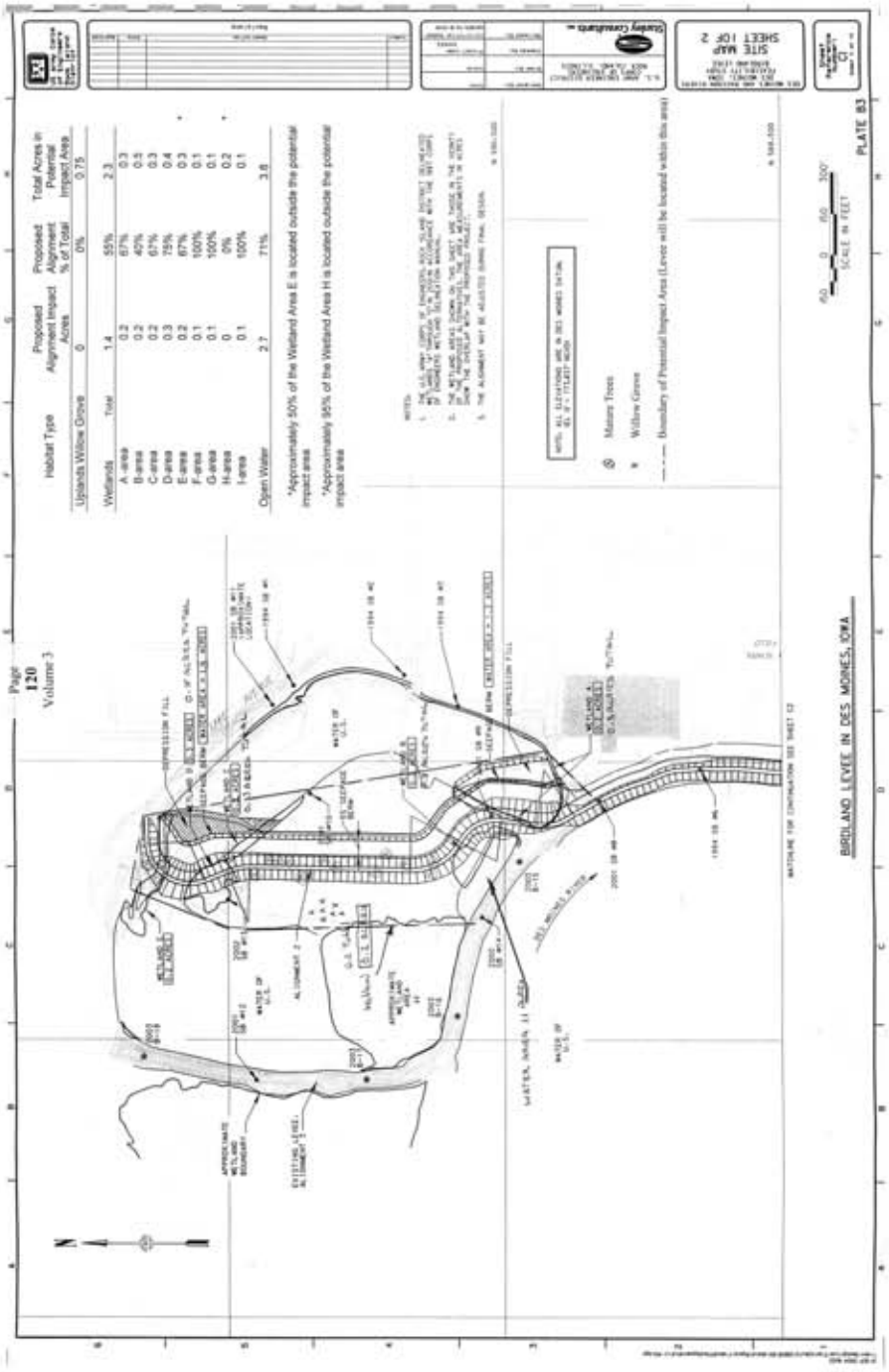
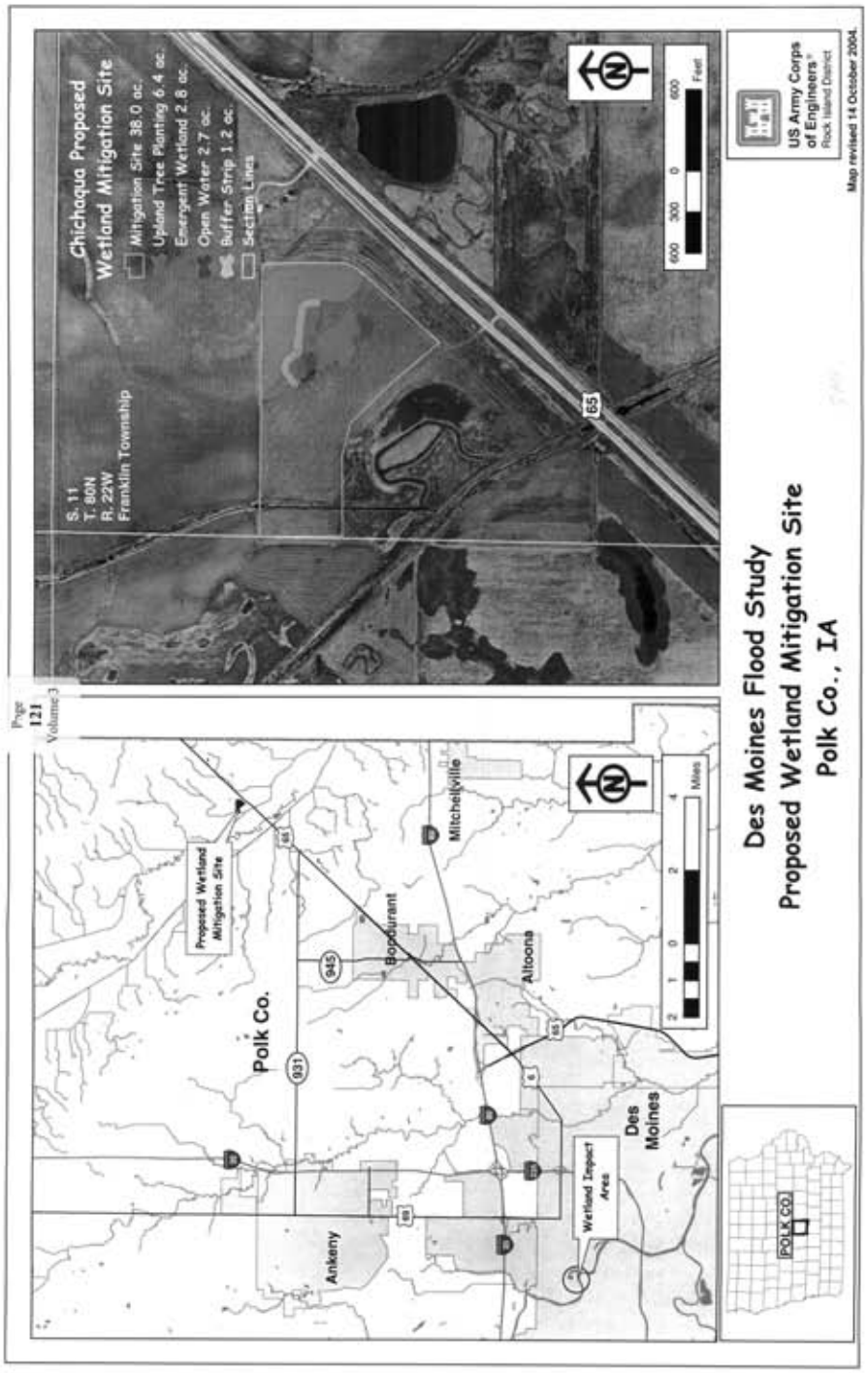


Exhibit "C"
Page
118
Volume 3
C


Des Moines & Raccoon Rivers Feasibility Study, Polk Co., IA Environmental Impact & Mitigation Sites
POLK CO.
US Army Corps of Engineers®
Rock Island District
Map produced 13 October 2004.
Page 119 Volume 3
Polk Co.
Proposed Chichaqua Wetland & Upland Forest Mitigation Site
Bondurant
Mitchellville
Altoona
Ankeny
Saylorville Reservoir
Saylorville Dam
Birdland Wetland Impact Area
Central Place Upland Forest Mitigation Site
Birdland Upland Forest Impact Area
Central Place Wetland Mitigation Site
Birdland Park Levee, Reach 1
Central Place Levee, Reach 2
Fourmile Creek, Reach 10
Downtown West Levee, Reach 4
Downtown East Levee, Reach 3
Leetown Creek, Reach 3
Downtown South Levee, Reach 5
Red Rock Renewal Wetland Levee
Walnut Cr. at Grand Ave., Reach 9
Des Moines Water Works Levee, Reach 7
Raccoon River Sect. 205, Reach 6
Des Moines & West Des Moines Levees, Reach 8
0 0.5 1 2 3 4 Miles


Page 120 Volume 3
BIRDLAND LEVEE IN DES MOINES, IOWA
PLATE 83
SITE MAP
SHEET 1 OF 2
Habitat Type
Proposed Alignment Impact Acres
Proposed Alignment % of Total
Total Acres in Potential Impact Area
Uplands Willow Grove 0 0% 0.75
Wetlands Total 1.4 55% 2.3
A-area 0.2 67% 0.3
B-area 0.2 40% 0.5
C-area 0.2 67% 0.3
D-area 0.3 75% 0.4
E-area 0.2 67% 0.3
F-area 0.1 100% 0.1
G-area 0.1 100% 0.1
H-area 0 0% 0.2
I-area 0.1 100% 0.1
Open Water 2.7 71% 3.8
*Approximately 50% of the Wetland Area E is located outside the potential impact area
*Approximately 95% of the Wetland Area H is located outside the potential impact area
Mature Trees
Willow Grove
Boundary of Potential Impact Area (Levee will be located within this area)
SCALE IN FEET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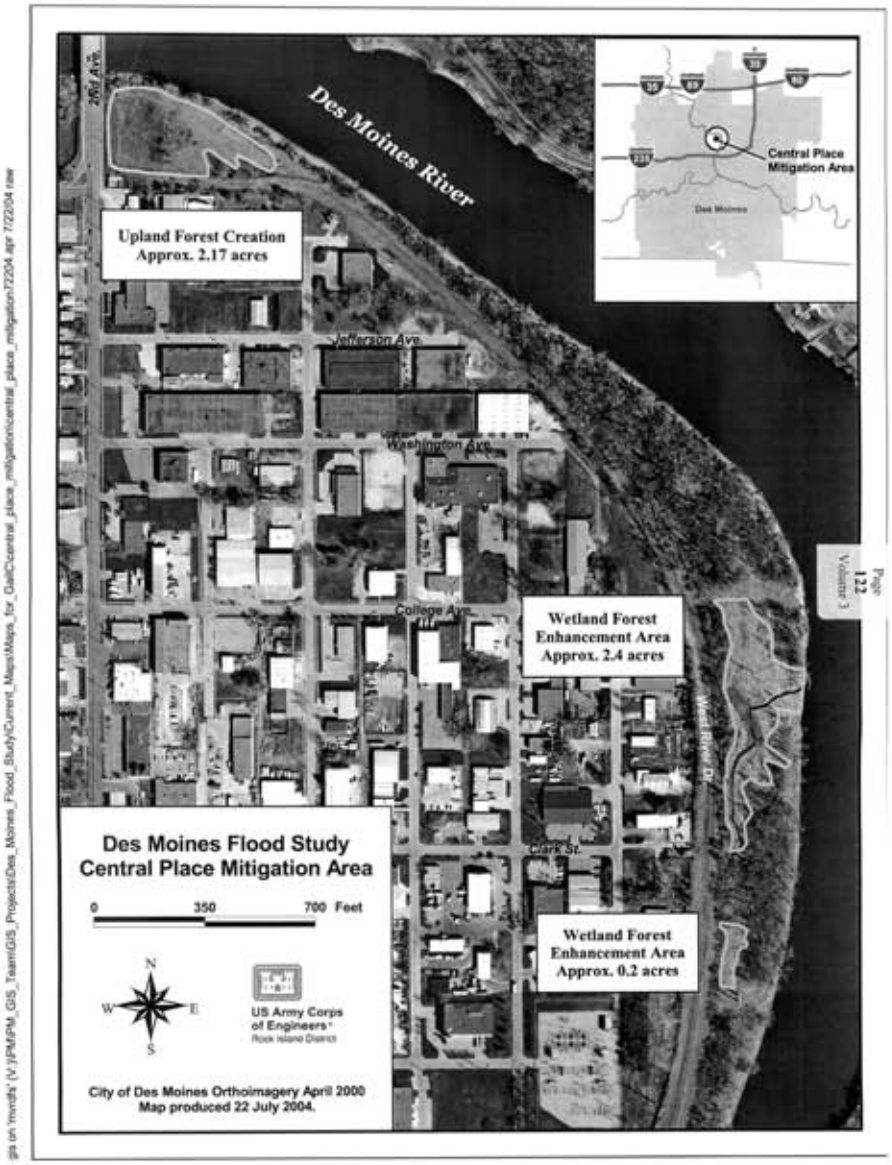
Des Moines Flood Study
Proposed Wetland Mitigation Site
Polk Co., IA
Chichaqua Proposed Wetland Mitigation Site
Mitigation Site 38.0 ac.
Upland Tree Planting 6.4 ac.
Emergent Wetland 2.8 ac.
Open Water 2.7 ac.
Buffer Strip 1.2 ac.
Section Lines
S. 11
T. 80N
R. 22W
Franklin Township
Proposed Wetland Mitigation Site
Polk Co.
Ankeny
Bondurant
Altoona
Mitchellville
Des Moines
Wetland Impact Area
POLK CO.
Miles
Feet
US Army Corps of Engineers
Rock Island District
Map revised 14 October 2004


Des Moines River
26th Ave.
Upland Forest Creation
Approx. 2.17 acres
Jefferson Ave
Washington Ave
College Ave
Wetland Forest
Enhancement Area
Approx. 2.4 acres
Clark St
Wetland Forest
Enhancement Area
Approx. 0.2 acres
Central Place
Mitigation Area
Des Moines
Des Moines Flood Study
Central Place Mitigation Area
0
350
700 Feet
N
W
E
S
US Army Corps
of Engineers
Rock Island District
City of Des Moines Orthoimagery April 2000
Map produced 22 July 2004.
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122
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