Final Independent External Peer Review Report of Revisions to the Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study Report, North Dakota and Minnesota

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Ecosystem Restoration Planning Center of Expertise
Baltimore District

Contract No. W912HQ-10-D-0002
Task Order: 0014

July 7, 2011

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FINAL
INDEPENDENT EXTERNAL PEER REVIEW REPORT

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Revisions to the Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study Report, North Dakota and Minnesota

EXECUTIVE SUMMARY

Project Background and Purpose

Fargo-Moorhead is located on the Red River of the North, but the Wild Rice, Sheyenne, Maple, and Rush Rivers in North Dakota and the Buffalo River in Minnesota also cross the study area. The primary problem in the study area is a high risk of flood damage to urban infrastructure from the Red River of the North, the Wild Rice River, the Buffalo River, and the Sheyenne River. Fargo and Moorhead are on the west and east banks, respectively, of the Red River of the North, approximately 453 river miles south of the mouth of the river at Lake Winnipeg in Manitoba, Canada. The drainage area of the Red River of the North above the U.S. Geological Survey gauging station at Fargo is approximately 6,800 square miles, of which about 2,175 square miles do not contribute to runoff.

The Fargo-Moorhead metropolitan area has a relatively high risk of flooding. The highest river stages usually occur as a result of spring snowmelt, but summer rainfall events have also caused significant flood damage. The Red River of the North has exceeded the National Weather Service flood stage of 17 feet in 52 of the past 108 years, and every year from 1993 through 2010. The study area is between the Wild Rice River, the Sheyenne River, and the Red River of the North; interbasin flows complicate the hydrology of the region and contribute to extensive flooding. Average annual flood damages in the Fargo-Moorhead metropolitan area are currently estimated at more than $195.9 million.

The planning objectives of the study are to:

- Reduce flood risk and flood damages in the Fargo-Moorhead metropolitan area.
- Restore or improve degraded riverine and riparian habitat in and along the Red River of the North, Wild Rice River (North Dakota), Sheyenne River (North Dakota), and Buffalo River (Minnesota).
- Provide additional wetland habitat in conjunction with other project features.
- Provide recreational opportunities in conjunction with other project features.

A draft feasibility report recommending a project to address flood risk management, ecosystem restoration, and recreation needs of the study area was completed by the U.S. Army Corps of Engineers (USACE) St. Paul District in February 2010. An Independent External Peer Review

(IEPR) of the draft feasibility report, Draft Environmental Impact Statement, and technical appendices (DFR/EIS) was initiated in February 2010, and the documents to be reviewed were provided to the IEPR panel in March 2010. The Final IEPR Report was completed in May 2010 and the USACE/IEPR panel comment and response process was completed in July 2010.

Subsequent higher level review within USACE resulted in substantive revisions to the documents that had undergone IEPR. Generally these revisions do not affect the recommendations of the study report, but pertain more to their associated impacts. These revisions are considered sufficiently extensive to warrant an IEPR of those changes.

Independent External Peer Review Process

USACE is conducting an IEPR of Revisions to the Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study (FS) Report, North Dakota and Minnesota (hereinafter Revised Fargo-Moorhead FS). Battelle, as a 501(c)(3) non-profit science and technology organization with experience in establishing and administering peer review panels for USACE, was engaged to coordinate the IEPR of the Fargo-Moorhead DFR/EIS, as well as the IEPR of the Revised Fargo-Moorhead FS. Independent, objective peer review is regarded as a critical element in ensuring the reliability of scientific analyses. The IEPR was external to the agency and conducted following USACE and Office of Management and Budget (OMB) guidance described in USACE (2010), USACE (2007), and OMB (2004). This final report describes the IEPR process, describes the panel members and their selection, and summarizes the Final Panel Comments of the IEPR Panel (the Panel).

Per the USACE Statement of Work, Battelle contracted with the five panel members selected for the Fargo-Moorhead DFR/EIS IEPR conducted in 2010. The final panel members covered technical expertise in the following key areas: National Environmental Policy Act (NEPA) and biology; hydrology and hydraulic engineering; geotechnical engineering; economics; and civil design/construction cost engineering.

The Panel received electronic versions of the Revised Fargo-Moorhead FS documents, totaling more than 3,300 pages, along with a charge that solicited comments on specific sections of the documents to be reviewed. The charge was prepared by Battelle according to guidance provided in USACE (2010) and OMB (2004). Charge questions were provided by USACE and included in the draft and final Work Plans.

The USACE Project Delivery Team briefed the Panel and Battelle on the revisions during a kick-off meeting held via teleconference prior to the start of the review. The Panel produced more than 150 individual comments in response to the 61 charge questions.

IEPR panel members reviewed the Revised Fargo-Moorhead FS documents individually. The panel members then met via teleconference with Battelle to review key technical comments, and reach agreement on the Final Panel Comments to be provided to USACE. Each Final Panel Comment was documented using a four-part format consisting of: (1) a comment statement; (2) the basis for the comment; (3) the significance of the comment (high, medium, or low); and (4) recommendations on how to resolve the comment. Overall, 16 Final Panel Comments were

identified and documented. Of these, one was identified as having high significance, 11 had medium significance, and four had low significance.

Results of the Independent External Peer Review

The panel members agreed among one another on their "assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" (USACE, 2010; p. D-4) in the Revised Fargo-Moorhead FS document. Table ES-1 lists the Final Panel Comments statements by level of significance. The full text of the Final Panel Comments is presented in Appendix A of this report. The following statements summarize the Panel's findings.

Economics: The Panel found that the economic and construction cost analyses are sound and comprehensive. However, the cost of the fish passage facilities does not appear to be justified based on the limited time these facilities would be in operation. Additional analysis should be performed to determine the importance of fish passage during flood season. In addition, the use of the steady state hydraulic model for the metro area flood damages estimate is not fully justified and therefore calls into question the benefit estimation for the Locally Preferred Plan (LPP).

Engineering: The Panel found that hydrologic, hydraulic, and geotechnical analyses are sound and comprehensive. The proposed project design is robust and resilient; however, the design capacity of the system could be exceeded by extreme flood events. The proposed design of the spoil piles could be improved by optimizing the maximum spoil pile height while considering side slope stability, thereby minimizing land area requirements. Also, the report does not identify whether the spoil piles could be used for agricultural purposes after completion of the construction. This could affect project real estate costs.

The flood risk management plan is complicated and depends on the timely and correct operation of the two gated structures controlling flows to the Red and Wild Rice Rivers in anticipation of major flood events. An operation plan needs to be developed to define the process for predicting major hydrologic events, responsibilities for gate operation, and long term maintenance and periodic testing items. In addition, provisions need to be made for operation in case of a power failure. A plan, along with assigned responsibilities, should be developed for real-time adjustments to the operation of the two gate systems during flood events.

Environmental: The Panel found that the environmental analyses are sound and comprehensive. However, the report does not address the effects of the project on amphibian and reptile fauna. The placement of baffles or protruding rock boulders on the bottom of the fish passages at the gate structures may result in entrainment and mortality due to high water velocities expected during tainter gate closure. The high velocities may also create downstream scour. In addition, the effect of water recession on fish escapement from the canal channel is not analyzed. Finally, contemporary survey data describing potential impacts to freshwater mussels during project construction are not provided.

Table ES-1. Overview of 16 Final Panel Comments Identified by the Revised Fargo-Moorhead FS IEPR Panel

Significance – High	
1	The potential risks, both mechanical as well as hydrologic, associated with the operation of the gates at the diversion control structures do not seem to be considered in the feasibility analysis.
Significance – Medium	
2	The risks and uncertainties associated with the performance of the hydraulic structures under dynamic conditions are not fully addressed.
3	The impacts of overtopping of the CR17 tieback levee under extreme flood conditions are not evaluated, and the related potential for increased damage and loss of life is not well defined.
4	The limitation of the maximum spoil pile height to 15 feet is not discussed or justified in the report.
5	The potential use of spoil piles for agricultural purposes, including those spoil piles that serve as levees, may impact real estate costs.
6	The assumption that the total sediment load will divide in proportion to the amount of water diverted may not be correct, and could have a negative impact on river morphology downstream of the diversions.
7	The current design of fish passages does not consider the effects of high flow velocity on the rock size used to protect against scour and fish collisions leading to an increase in mortality.
8	The risk to migrating fish due to the operating hydraulics of the proposed Red River control structure has not been fully considered.
9	The effect of water recession on fish escapement from the diversion channel has not been analyzed, and may impact fish mortality.
10	The report does not address the impact of project construction and operation on mussel populations.
11	The amphibian and reptile fauna have not been considered in the environmental impact analysis.
12	There appear to be inconsistencies and overstated benefits associated with the use of the steady Phase III hydraulic model to estimate expected annual damages in the metro area of the Red River.
Significance – Low	
13	Comparable hydrologic and hydraulic models and methods have not been used to develop the LPP and Federally Comparable Plan (FCP) and limit the ability to accurately differentiate the impacts of the alternatives.
14	The economic analyses of the future “with” and “without project” conditions provided in Appendix C and the Regional Economic Development section are inconsistent.
15	A sensitivity analysis has not been conducted to determine the flood fight success rate needed to make the LPP or the FCP infeasible.
16	Costs for individual features are not provided in the Total Project Cost Summary (TPCS), which impairs the ability to define annual project improvements.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ACRONYMS

AGU	American Geophysical Union
ASCE	American Society of Civil Engineers
ATR	Agency Technical Review
CFD	Computational Fluid Dynamics
COI	Conflict of Interest
CSSC	Chicago Sanitary and Ship Canal
CWRB	Civil Works Review Board
DrChecks	Design Review and Checking System
DFR	Draft Feasibility Report
EEAB	Equivalent Expected Annual Benefit
EEAD	Equivalent Expected Annual Damage
EIS	Environmental Impact Statement
EOE	Expert Opinion Elicitation
ERDC	Engineer Research and Development Center
FCP	Federally Comparable Plan
FDA	Flood Damage Analysis
FMMFS	Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study
FS	Feasibility Study
HEC-RAS	Hydrologic Engineering Centers River Analysis System
IAHR	International Journal of Hydraulic Research
IEPR	Independent External Peer Review
LPP	Locally Preferred Plan
NED	National Economic Development
NEPA	National Environmental Policy Act
OMB	Office of Management and Budget
POP	Period of Performance
QA	Quality Assurance
TARP	Troubled Asset Relief Program
TPCS	Total Project Cost Summary
USACE	United States Army Corps of Engineers

USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WSP	Water Surface Profiles

1. INTRODUCTION

Fargo-Moorhead is located on the Red River of the North, but the Wild Rice, Sheyenne, Maple, and Rush Rivers in North Dakota and the Buffalo River in Minnesota also cross the study area. The primary problem in the study area is a high risk of flood damage to urban infrastructure from the Red River of the North, the Wild Rice River, the Buffalo River, and the Sheyenne River. Fargo and Moorhead are on the west and east banks, respectively, of the Red River of the North, approximately 453 river miles south of the mouth of the river at Lake Winnipeg in Manitoba, Canada. The drainage area of the Red River of the North above the U.S. Geological Survey gauging station at Fargo is approximately 6,800 square miles, of which about 2,175 square miles do not contribute to runoff.

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Subsequent higher level review within USACE resulted in substantive revisions to the documents that had undergone IEPR. Generally these revisions do not affect the recommendations of the study report, but pertain more to their associated impacts. These revisions are considered sufficiently extensive to warrant an IEPR of those changes.

The objective of the work described here was to conduct an IEPR of the Revisions to the Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study (FS) Report, North Dakota and Minnesota (hereinafter Revised Fargo-Moorhead FS) in accordance with procedures described in the Department of the Army, USACE Engineer Circular *Civil Works Review Policy* (EC No. 1165-2-209) (USACE, 2010), USACE CECW-CP memorandum *Peer Review Process* (USACE, 2007), and Office of Management and Budget (OMB) bulletin *Final Information Quality Bulletin for Peer Review* (OMB, 2004). Battelle, as a 501(c)(3) non-profit science and technology organization with experience in establishing and administering peer review panels, was engaged to coordinate the IEPR of the Fargo-Moorhead DFR/EIS, as well as the IEPR of the Revised Fargo-Moorhead FS. Independent, objective peer review is regarded as a critical element in ensuring the reliability of scientific analyses.

This final report details the IEPR process, describes the IEPR panel members and their selection, and summarizes the Final Panel Comments of the IEPR Panel on the existing environmental, economic, and engineering analyses contained in the Revised Fargo-Moorhead FS. The full text of the Final Panel Comments is presented in Appendix A.

2. PURPOSE OF THE IEPR

To ensure that USACE documents are supported by the best scientific and technical information, USACE has implemented a peer review process that uses IEPR to complement the Agency Technical Review (ATR), as described in USACE (2010) and USACE (2007).

In general, the purpose of peer review is to strengthen the quality and credibility of the USACE decision documents in support of its Civil Works program. IEPR provides an independent assessment of the economic, engineering, and environmental analysis of the project study. In particular, the IEPR addresses the technical soundness of the project study's assumptions, methods, analyses, and calculations and identifies the need for additional data or analyses to make a good decision regarding implementation of alternatives and recommendations.

In this case, the IEPR of the Revised Fargo-Moorhead FS was conducted and managed using contract support from Battelle, which is an Outside Eligible Organization under Section 501(c)(3) of the U.S. Internal Revenue Code with experience conducting IEPRs for USACE.

3. METHODS

This section describes the methods followed in selecting the members for the IEPR Panel (the Panel) and in planning and conducting the IEPR. The IEPR was conducted following procedures described by USACE (2010) and in accordance with USACE (2007) and OMB (2004) guidance. Supplemental guidance on evaluation for conflicts of interest (COIs) was obtained from the *Policy on Committee Composition and Balance and Conflicts of Interest for Committees Used in the Development of Reports* (The National Academies, 2003).

3.1 Planning and Schedule

At the beginning of the Period of Performance (POP), Battelle held a kick-off meeting with USACE to review the preliminary/suggested schedule, discuss the IEPR process, and address any questions regarding the scope (e.g., clarify expertise areas needed for panel members). Any revisions to the schedule were submitted as part of the final Work Plan.

Table 1 defines the schedule followed in executing the IEPR. Due dates for milestones and deliverables are based on the POP date of April 21, 2011. Note that the work items listed in Task 7 occur after the submission of this report. Battelle will enter the 16 Final Panel Comments developed by the Panel into USACE's Design Review and Checking System (DrChecks), a Web-based software system for documenting and sharing comments on reports and design documents, so that USACE can review and respond to them. USACE will provide responses (Evaluator Responses) to the Final Panel Comments, and the Panel will respond (BackCheck Responses) to the Evaluator Responses. All USACE and Panel responses will be documented by Battelle.

Table 1. Revised Fargo-Moorhead FS IEPR Schedule

TASK	ACTION	DUE DATE
1	**Award/Effective Date (Start of Period of Performance)**	4/21/2011
	Review documents available	4/21/2011
	Battelle submits draft Work Plan [a]	4/29/2011
	USACE provides comments on draft Work Plan	5/6/2011
	Battelle convenes teleconference (if necessary)	5/6/2011
	Battelle submits final Work Plan [a]	5/9/2011
2	Battelle requests input from USACE on the COI questionnaire	4/22/2011
	USACE provides comments on COI questionnaire	4/25/2011
	Battelle submits list of selected panel members [a]	4/27/2011
	USACE provides comments on selected panel members	4/28/2011
	Battelle completes subcontracts for panel members	5/11/2011
3	USACE provides Charge to be included in Work Plan	4/28/2011
4	USACE/Battelle kick-off meeting	4/27/2011
	Battelle sends review documents to IEPR Panel	5/12/2011
	USACE/Battelle/Panel kick-off meeting	5/12/2011
	Battelle and Panel member attend CWRB (to be determined)	9/23/2011
5	Panel members complete their individual reviews	6/6/2011
	Battelle convenes Panel Review Teleconference	6/10/2011
	Panel members provide draft Final Panel Comments to Battelle	6/20/2011
6	Battelle submits Final IEPR Report to USACE [a]	7/7/2011

TASK	ACTION	DUE DATE
7 [b]	Battelle inputs Final Panel Comments to DrChecks; Battelle provides Comment Response template to USACE	7/11/2011
	Battelle convenes teleconference with USACE to review the Comment Response Process	7/11/2011
	USACE provides draft Evaluator Responses to Battelle	7/21/2011
	Battelle convenes teleconference with Panel and USACE to discuss Final Panel Comments, and draft responses	7/28/2011
	USACE inputs final Evaluator Responses in DrChecks	8/3/2011
	Battelle inputs the Panel's BackCheck Responses in DrChecks	8/11/2011
	Battelle submits pdf printout of DrChecks project file [a]	8/11/2011
	End of Period of Performance	9/30/2011

[a] Deliverable.

[b] Task 7 occurs after the submission of this report.

3.2 Identification and Selection of IEPR Panel Members

Per the USACE Statement of Work, Battelle contracted with the five panel members selected for the Fargo-Moorhead DFR/EIS IEPR conducted in 2010. The final panel members covered technical expertise in the following key areas: National Environmental Policy Act (NEPA) and biology; hydrology and hydraulic engineering; geotechnical engineering; economics; and civil design/construction cost engineering.

Prior to contracting with the panel members, they were screened for the following potential exclusion criteria or COIs.[1] These COI questions were intended to serve as a means of disclosure and to better characterize a candidate's employment history and background. Providing a positive response to a COI screening question did not automatically preclude a panel member from serving on the Panel.

- Involvement by you or your firm[2] in any part of the Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study, including the Draft Fargo-Moorhead Metro, Flood Risk Management Project, Red River of the North, Fargo, North Dakota and Moorhead, Minnesota, Feasibility Report, EIS, and supporting appendicies.

[1] Battelle evaluated whether scientists in universities and consulting firms that are receiving USACE-funding have sufficient independence from USACE to be appropriate peer reviewers. See OMB (2004, p. 18), "….when a scientist is awarded a government research grant through an investigator-initiated, peer-reviewed competition, there generally should be no question as to that scientist's ability to offer independent scientific advice to the agency on other projects. This contrasts, for example, to a situation in which a scientist has a consulting or contractual arrangement with the agency or office sponsoring a peer review. Likewise, when the agency and a researcher work together (e.g., through a cooperative agreement) to design or implement a study, there is less independence from the agency. Furthermore, if a scientist has repeatedly served as a reviewer for the same agency, some may question whether that scientist is sufficiently independent from the agency to be employed as a peer reviewer on agency-sponsored projects."

[2] Includes any joint ventures in which your firm is involved and if your firm serves as a prime or as a subcontractor to a prime. Please clarify which relationship exists.

- Involvement by you or your firm[2] in any work related to the Red River of the North Basin, including the Fargo-Moorhead Metropolitan Area.
- Involvement by you or your firm[2] in any work on the Red River Basin Reconnaissance Study.
- Involvement by you or your firm[2] in the conceptual or actual design, construction, or operation and maintenance of flood damage reduction projects in the Fargo-Moorhead Metropolitan Area or the Red River of the North Basin.
- Current employment by the USACE.
- Involvement with paid or unpaid expert testimony related to the Red River of the North Basin, including the Fargo-Moorhead Metropolitan Area.
- Current or previous employment or affiliation with the non-Federal sponsors, including the City of Fargo, North Dakota, Cass County, North Dakota, the City of Moorhead, Minnesota, Clay County, Minnesota or any of the following Federal, state, county, local, and regional agencies, environmental organizations, and interested groups: the Red River Basin Commission, International Red River Board, Red River Watershed Management Board, North Dakota Red River Joint Water Resource District, Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, Minnesota Department of Transportation, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, North Dakota Game, Fish and Parks, Fargo-Moorhead Metropolitan Council of Governments, North Dakota State Water Commission, North Dakota Department of Health, Federal Emergency Management Agency, North Dakota Wildlife Federation, Buffalo Red River Watershed District, Cass County, North Dakota, Clay County, Minnesota, Southeast Cass Water Resources District, Federal Aviation Administration, Minnesota Natural Resource Conservation Service, North Dakota Natural Resource Conservation Service, North Dakota Natural Resources Trust, National Wildlife Federation, Minnesota Board of Water and Soil Resources, and currently working on Fargo-Moorhead Metropolitan Area or Red River of the North Basin-related projects (for pay or pro bono).
- Past, current, or future interests or involvements (financial or otherwise) related to the Fargo-Moorhead Metropolitan Area.
- Current personal involvement with other USACE projects, including whether involvement was to author any manuals or guidance documents for USACE. If yes, provide titles of documents or description of project, dates, and location (USACE district, division, Headquarters, Engineer Research and Design Center (ERDC), etc.), and position/role. Please highlight and discuss in greater detail any projects that are specifically with the St. Paul District.
- Current firm[2] involvement with other USACE projects, specifically those projects/contracts that are with the St. Paul District. If yes, provide title/description, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role.
- Previous employment by the USACE as a direct employee or contractor (either as an individual or through your firm[2]) within the last 10 years, notably if those projects/contracts are with the St. Paul District. If yes, provide title/description, dates

employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.

- Previous experience conducting technical peer reviews. If yes, please highlight and discuss any technical reviews concerning flood risk reduction, and include the client/agency and duration of review (approximate dates).
- Pending, current or future financial interests in the Fargo-Moorhead Metropolitan Area or Red River of the North Basin related contracts/awards from USACE.
- A significant portion (i.e., greater than 50%) of personal or firm[2] revenues within the last 3 years came from USACE contracts.
- Any publicly documented statement (including, for example, advocating for or discouraging against) related to the Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study, including the Draft Fargo-Moorhead Metro, Flood Risk Management Project, Red River of the North, Fargo, North Dakota & Moorhead, Minnesota, Feasibility Report, EIS, and supporting appendices.
- Participation in relevant prior Federal studies relevant to this project:
  - USACE, May 1967. Flood Control Reconnaissance Report, Red River of the North at Fargo, North Dakota, Section 205
  - USACE, May 1985. Fargo-Moorhead Urban Study
  - International Joint Commission, November 2000. "Living with the Red"
  - USACE, September 2001. Reconnaissance Study, Red River Basin, Minnesota, North Dakota, South Dakota
  - U.S. Department of the Interior, Bureau of Reclaimation, December 2007. Final Environmental Impact Statement for the Red River Valley Water Supply Project
  - USACE, August 2004. Fargo-Moorhead and Upstream Feasibility Study
  - Red River Diversion Fargo-Moorhead Metro Flood Risk
  - Management Project Feasibility Study - Phase 4. USACE, April 2011
  - Supplemental Draft Feasibility Report and Environmental Impact Statement, Fargo-Moorhead Metropolitan Area Flood Risk Management. USACE, April 2011.
- Participation in prior non-Federal studies relevant to this project such as,
  - City of Fargo and City of Moorhead, June 2007, Fargo-Moorhead Downtown Framework Plan Update
  - City of Fargo, Fargo Southside Flood Control Project
  - Flood risk management reduction project for Oakport Township, Minnesota.
- Is there any past, present, or future activity, relationship, or interest (financial or otherwise) that could make it appear that you would be unable to provide unbiased services on this project? If so, please describe.

The five final reviewers were either affiliated with academic institutions or consulting companies. Battelle established subcontracts with the panel members when they indicated their willingness to participate and confirmed the absence of COIs through a signed COI form. USACE was given the list of candidate panel members, but Battelle made the final selections of

the Panel. Section 4 of this report provides names and biographical information on the panel members.

Prior to beginning their review and within one day of their subcontracts being finalized, all members of the Panel attended a kick-off meeting via teleconference planned and facilitated by Battelle in order to review the IEPR process, the schedule, communication procedures, and other pertinent information for the Panel.

3.3 Preparation of the Charge and Conduct of the IEPR

Charge questions were provided by USACE and included in the draft and final Work Plans. In addition to a list of 61 charge questions/discussion points, the final charge included general guidance for the Panel on the conduct of the peer review (provided in Appendix B of this final report).

Battelle planned and facilitated a final kick-off meeting via teleconference during which USACE presented project details to the Panel. Before the meeting, the IEPR Panel received an electronic version of the final charge as well as the Revised Fargo-Moorhead FS documents and reference materials listed below. The documents and files in bold font were provided for review; each panel member focused his or her review on particular sections of the revised project documents as specified by USACE. Other documents listed below were provided for reference or supplemental information only.

- **Draft Main Report/Draft EIS**
- **Appendix A: Hydrology**
- **Appendix B: Hydraulics**
- **Appendix C: Economics**
- **Appendix D: Other Social Effects**
- Appendix E: Cultural Resources
- **Appendix F: Environmental**
- Appendix G: Real Estate
- Appendix H: Credit to Existing Levees
- **Appendix I: Geotechnical Engineering**
- **Appendix J: Structural**
- Appendix K: Civil Engineering
- **Appendix L: Cost Engineering**
- Appendix M: Recreation and Aesthetics
- Appendix N: Not Used
- Appendix O: Plan Formulation
- Appendix P: Non-Structural
- Appendix Q: Public Involvement and Coordination

- Appendix R: DEIS Public and Private Comments Received
- Appendix S: DEIS Public and Private Summarized Comments and Corps Responses
- **Plan Plates**
- **AE Appendix ("Attachment 5 – Consultant's Report")**
- USACE guidance *Civil Works Review Policy* (EC 1165-2-209) dated January 31, 2010
- CECW-CP Memorandum dated March 31, 2007
- Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* released December 16, 2004.

Throughout the review period, USACE was available to provide additional documents at the request of panel members. These additional documents were provided to Battelle and then disseminated to the Panel as supplemental information only and were not part of the official review:

- Fargo-Moorhead Metro Feasibility Study History and Context for Follow up IEPR.

3.4 Review of Individual Comments

The Panel was instructed to address the charge questions/discussion points on a comment-response form provided by Battelle. At the end of the review period, the Panel produced approximately 150 individual comments in response to the charge questions/discussion points. Battelle reviewed the comments to identify overall recurring themes, areas of potential conflict, and other overall impressions. As a result of the review, Battelle summarized the 150 comments into a preliminary list of 21 overall comments and discussion points. Each panel member's individual comments were shared with the full Panel in a merged individual comments table.

3.5 IEPR Panel Teleconference

Battelle facilitated a 4-hour teleconference with the Panel so that the panel members, many of whom are from diverse scientific backgrounds, could exchange technical information. The main goal of the teleconference was to identify which issues should be carried forward as Final Panel Comments in the Final IEPR Report and decide which panel member would serve as the lead author for the development of each Final Panel Comment. This information exchange ensured that the Final IEPR Report would accurately represent the Panel's assessment of the project, including any conflicting opinions. The Panel engaged in a thorough discussion of the overall positive and negative comments, added any missing issues of high-level importance to the findings, and merged any related individual comments. In addition, Battelle confirmed each Final Panel Comment's level of significance to the Panel.

At the end of these discussions, the Panel identified 15 comments and discussion points that should be brought forward as Final Panel Comments.

3.6 Preparation of Final Panel Comments

Following the teleconference, Battelle prepared a summary memorandum for the Panel documenting each Final Panel Comment (organized by level of significance). The memorandum

provided the following detailed guidance on the approach and format to be used to develop the Final Panel Comments for the Revised Fargo-Moorhead FS:

- Lead Responsibility: For each Final Panel Comment, one panel member was identified as the lead author responsible for coordinating the development of the Final Panel Comment and submitting it to Battelle. Battelle modified lead assignments at the direction of the Panel. To assist each lead in the development of the Final Panel Comments, Battelle distributed the merged individual comments table, a summary detailing each draft final comment statement, an example Final Panel Comment following the four-part structure described below, and templates for the preparation of each Final Panel Comment.
- Directive to the Lead: Each lead was encouraged to communicate directly with other IEPR panel members as needed and to contribute to a particular Final Panel Comment. If a significant comment was identified that was not covered by one of the original Final Panel Comments, the appropriate lead was instructed to draft a new Final Panel Comment.
- Format for Final Panel Comments: Each Final Panel Comment was presented as part of a four-part structure:
  1. Comment Statement (succinct summary statement of concern)
  2. Basis for Comment (details regarding the concern)
  3. Significance (high, medium, low; see description below)
  4. Recommendation(s) for Resolution (see description below)
- Criteria for Significance: The following were used as criteria for assigning a significance level to each Final Panel Comment:
  1. High: Describes a fundamental problem with the project that could affect the recommendation, success, or justification of the project. Comments rated as high indicate that the Panel analyzed or assessed the methods, models, and/or analyses and determined that there is a "showstopper" issue.
  2. Medium: Affects the completeness of the report in describing the project, but will not affect the recommendation or justification of the project. Comments rated as medium indicate that the Panel does not have sufficient information to analyze or assess the methods, models, or analyses.
  3. Low: Affects the understanding or accuracy of the project as described in the report, but will not affect the recommendation or justification of the project. Comments rated as low indicate that the Panel identified information (tables, figures, equations, discussions) that was mislabeled or incorrect, or data or report sections that were not clearly described or presented.
- Guidance for Developing Recommendations: The recommendation section was to include specific actions that USACE should consider to resolve the Final Panel Comment (e.g., suggestions on how and where to incorporate data into the analysis, how and where to address insufficiencies, areas where additional documentation is needed).

During preparation of the Final Panel Comments, an additional issue was identified for which the panel determined a Final Panel Comment should be developed. At the end of this process, 16

Final Panel Comments were prepared and assembled. Battelle reviewed and edited the Final Panel Comments for clarity, consistency with the comment statement, and adherence to guidance on the Panel's overall charge, which included ensuring that there were no comments regarding either the appropriateness of the selected alternative or USACE policy. There was no direct communication between the Panel and USACE during the preparation of the Final Panel Comments. The Final Panel Comments are presented in Appendix A of this report.

4. PANEL DESCRIPTION

Per the USACE Statement of Work, Battelle contracted with the five panel members selected for the Fargo-Moorhead DFR/EIS IEPR conducted in 2010. An overview of the credentials of the final five members of the Panel and their qualifications in relation to the technical evaluation criteria is presented in Table 2. More detailed biographical information regarding each panel member and his or her area of technical expertise is presented in the text that follows the table.

Table 2. Revised Fargo-Moorhead FS IEPR Panel: Technical Criteria and Areas of Expertise

	Kulik	Garcia	Spaulding	Greene	Love
NEPA and Biology (one expert needed)	**X**				
Familiar with large, complex Civil Works Projects with high public and interagency interests	X				
Particular knowledge of fisheries biology	X				
Experience with fish passage, migration, and spawning	X		X		
Knowledge of flood risk management projects	X				
Familiar with all NEPA requirements	X		X		
Familiarity with wetland and riparian ecology of the Upper Midwest	X				
Familiarity with the USACE planning process (beneficial)	X			X	
Hydrology and Hydraulic Engineering (one expert needed)		**X**			
Familiar with large, complex Civil Works Projects with high public and interagency interests		X			
Experience in hydrology and hydraulic engineering in large public works projects, associated flood risk management, diversion channel design, large river control structures		X			
Familiar with standard USACE hydrologic and hydraulic computer models		X			
Experience with computer simulation of large river systems		X			
Experience with physical modeling of large river systems		X			
Geotechnical Engineering (one expert needed)			**X**		
Experience in the analysis and design of flood risk/reduction type projects, especially			X		
Modeling seepage and slope stability analyses in soft clay soils			X		
Cold climate project experience			X		
Familiar with large, complex Civil Works Projects with high public and interagency interests			X		
Experience in the design and construction of levees and floodwalls, foundations for bridges, large river control structures, dams			X		
Familiar with earthwork required for the construction of levee/floodwall projects			X		
Familiar with major excavation for diversion channels			X		

	Kulik	Garcia	Spaulding	Greene	Love
Economics (one expert needed)				**X**	
Experience directly related to water resource economic evaluation or review				X	
Familiar with large, complex Civil Works Projects with high public and interagency interests				X	
Familiar with the USACE flood risk management analysis and benefit calculations, including use of standard USACE computer programs				X	
Experience with the National Economic Development analysis procedures, including those specifically related to flood risk management				X	
Civil Design/Construction Cost Engineering (one expert needed)					**X**
Demonstrated experience in performing cost engineering/construction management for all phases of flood risk management, or related projects					X
Familiar with large, complex Civil Works Projects with high public and interagency interests					X
Familiar with cost engineering related to similar flood risk management projects across the U.S., including those taking place in cold climates					X
Experience in associated contracting procedures, total cost growth analysis, and related cost risk analysis					X
Familiar with the construction industry					X

Marcelo Garcia, Ph.D., P.Eng.

Role: This panel member was chosen primarily for his hydrologic and hydraulic engineering experience and expertise.
Affiliation: University of Illinois, Urbana-Champaign

Dr. Marcelo Garcia, P.Eng., is the Chester and Helen Siess Professor and the Director of the Ven Te Chow Hydrosystems Laboratory in the Department of Civil and Environmental Engineering at the University of Illinois, Urbana-Champaign. He received his MSCE and Ph.D. in civil engineering from St. Anthony Falls Hydraulics Laboratory at the University of Minnesota. He has 27 years of experience in hydrologic and hydraulic engineering, and is a licensed professional engineer in Santa Fe, Argentina. His areas of expertise include river mechanics and sediment transport; environmental hydraulics; and water resources engineering.

Dr. Garcia has conducted hydrologic and hydraulic studies for the Parana Medio Dam in Argentina, the John Compton Dam in St. Lucia, West Indies, and the Valenciano Reservoir in Puerto Rico, and has directed development of a real-time hydrologic-hydraulic model for the $3 billion Deep Tunnel Troubled Asset Relief Program (TARP) project in Chicago, Illinois. Additionally, he has performed flood hazard analysis for Pilar, Paraguay, flood tunnel design in Buenos Aires, Argentina, and was responsible for the design of the flood control channel restoration for the Rio Piedras, Puerto Rico. Recently he worked on the design of a diversion scheme for flood control in Guayaquil, Ecuador. Dr. Garcia has also designed several spillways to prevent drowning accidents at low-head dams on the Fox and Vermillion Rivers in Illinois, and has also designed canoe chutes and fish passages for streams in Illinois and Kansas.

For more than 20 years he has taught graduate courses in open channel flow, hydraulic engineering and sediment transport that make use of USACE computer river models, and has published and lectured extensively on computer river modeling, including meandering streams and vegetated channels. Dr. Garcia has modeled several rivers numerically, including the Chicago River, Bubbly Creek and the Chicago Sanitary and Ship Canal (CSSC), the Fox River, the Wabash River, and the St. Clair River between Canada and the USA. Dr. Garcia has also led several physical movable-bed model studies, including erosion and sedimentation of the Minnesota River at Mankato, Minnesota, and bridge pier scour in the Tanana River, Alaska.

Dr. Garcia served as the editor-in-chief of the ASCE Manual of Engineering Practice 110 "Sedimentation Engineering" and the International Journal of Hydraulic Research (IAHR) from 2001 to 2006, and recently represented the United States in the sedimentation studies and computational modeling of the St. Clair River for the International Great Lakes Commission. Dr. Garcia was the 2006 recipient of the ASCE/EWRI/COPRI Hans Albert Einstein Award for contributions to the field of river engineering and sediment transport, and has authored or co-authored more than 200 peer reviewed publications and technical reports. He is a member of the American Society of Civil Engineers (ASCE), the International Association of Hydro-Environmental Engineering and Research (IAHR), the American Geophysical Union (AGU) and the National Academy of Engineering of Argentina.

Douglas Spaulding, P.E.

Role: This panel member was chosen primarily for his geotechnical engineering experience and expertise.
Affiliation: Spaulding Consultants, LLC

Mr. Douglas Spaulding, P.E. is a Principal with Spaulding Consultants, LLC, responsible for dam and levee design and inspection. He has 43 years of experience as a geotechnical engineer. He earned his MSCE from Purdue University, and is a Certified Professional Engineer in Wisconsin, North Dakota, Michigan, and Minnesota.

Mr. Spaulding served as Chief of Levee and Channel Design Section for USACE from 1973 to 1978, and managed environmental and technical studies for licensing or relicensing of more than 20 hydroelectric projects ranging in size from 600 kW to 1000 MW. As a FERC approved facilitator, Mr. Spaulding has facilitated Potential Failure Mode Analysis for more than 60 earth, arch, and gravity dams throughout the United States. He has served as the principal geotechnical designer for six levee and flood control projects in the Red River valley, and has also conducted geotechnical studies of levees in Red River to determine cause of levee cracking. Mr. Spaulding has provided geotechnical design for eight levee and floodwall projects located in Minnesota, North Dakota, and Wisconsin, and developed pile design for a pedestrian bridge in Grand Forks, North Dakota. He is experienced in stability analyses and seepage analyses using finite element techniques.

Mr. Spaulding has also served as a peer reviewer for the geotechnical design of various reaches of the New Orleans Flood Control Project, and has provided dam safety training to USACE and electric utility company operators for more than 25 years. Mr. Spaulding was responsible for the geotechnical design of the Highway 75 Dam in Minnesota, and the rehabilitation projects for more than 20 other dams throughout the United States. Mr. Spaulding's experience with major soft clays excavations for diversion channels includes the geotechnical design for the Breckenridge Diversion Channel (Minnesota), the Wild Rice Felton Ditch Project (Minnesota), the English Coulee Diversion Channel and control structure (Grand Forks, North Dakota), and preliminary design for the Roseau Channel Improvement Project.

Mr. Spaulding is a member of the American Society of Civil Engineers, the Minnesota Geotechnical Society, the Society of American Military Engineers, and the American Arbitration Association.

Gretchen Greene, Ph.D.

Role: This panel member was chosen primarily for her economics experience and expertise.
Affiliation: Environ, International Corp.

Dr. Gretchen Greene is a senior economist with Environ, Inc. She earned her Ph.D. in food and resource economics from the University of Florida in 1998. Dr. Greene has worked in environmental valuation, economic development, socioeconomic analysis, recreation demand, cost-benefit analysis, regulatory analysis, population projections, and forecasting urban water demand.

Dr. Greene has extensive experience with economic analysis of water resource development, having worked on numerous Indian Water Rights litigation cases that hinge on benefit cost analyses following the Principles and Guidelines for Water Resource Development, using the National Economic Development (NED) approach. She also led the Dredged Material Management Study: Risk-Based Analysis of the Lewiston Levee, which was part of a Dredged Material Management EIS for the Snake River system, in which Dr. Greene estimated flood damage reduction benefits of the Lewiston Levee system. Dr. Greene prepared a benefit-cost economic analysis of various dredge plans, levee alterations, and dredged material disposal options for the Walla Walla District of USACE. For this effort, she estimated flood damage reduction benefits using the USACE Hydrologic Engineering Center's (HEC) Flood Damage Analysis (FDA) model. The model and results were operated and presented in a manner consistent with USACE Engineering Manual 1110-2-1619, Risk Based Analysis for Flood Damage Reduction Studies. A Monte Carlo simulation approach was used to perform a risk-based analysis of flood damages over the project lifetime of the Lower Granite dam. Other costs estimated included cleanup costs, emergency care costs, transportation losses, and nonphysical damages such as lost wages, temporary housing, additional living expenses, and public infrastructure. Environmental costs and benefits were also analyzed, including consideration of effects of the project on endangered species, water quality, recreation, and wetlands. Dr. Greene also oversaw the development of a socioeconomic analysis of the region, including projections and a regional economic impact analysis.

In addition, Dr. Greene continues on-going research and work on the economic benefits of environmental services. For example, she recently worked with the Carson Water Subconservancy District to explore methods of calculating payments for ecological services to the farmers who experience winter flooding. HEC-RAS output was used to develop the estimates of the monetary value of attenuation, timing of floods (and emergency services costs), and flow changes.

David Love, P.E.

Role: This panel member was chosen primarily for his civil design and construction cost engineering experience and expertise.
Affiliation: Belt Collins West, Ltd.

Mr. David Love, P.E. has more than 38 years of experience in civil and water resource engineering and is the Principal at Belt Collins West, Ltd., which specializes in drainage and flood control projects in cold weather climates. He holds a B.S. in Engineering Physics from the Colorado School of Mines and has completed graduate coursework in hydraulics at the University of Colorado. He is also certified as a Professional Engineer in Colorado.

Mr. Love has completed dozens of floodplain and major drainageway masterplans, all of which have included cost engineering related to flood risk. Each of these projects typically includes flood damage and cost analysis under existing conditions; cost estimates to implement various flood control improvements; estimates for flood damages and cost analysis under proposed conditions; and a benefit-cost comparison. The recently completed South Platte River Flood Control Improvement project in Denver, Colorado is the most recent example of many large, complex projects with multiple project stakeholders on which he has worked. Mr. Love is

experienced in developing construction cost estimates for flood control improvement projects including flood proofing, as well as identifying long-term operation and maintenance costs for these flood control projects. Mr. Love is familiar with contracting procedures through his project experience working with local municipalities, special districts, various state and Federal agencies, as well as private sector clients. Approximately half of Mr. Love's project history has been related to the design and preparation of construction documents followed by a quality assurance (QA) role during construction activities. The QA experience has ranged from periodic site visits to observe construction activities to full-time construction management.

Mr. Love has been a featured speaker at several professional conferences and has given multiple engineering-related lectures at the University of Colorado's Schools of Engineering and Environmental Design at Boulder, Colorado. He has also taught construction inspection courses to multiple public works employees. Mr. Love is a member of the American Society of Civil Engineers, American Council of Engineering Consultants, Colorado Association of Stormwater and Floodplain Managers, Association of State Floodplain Managers, National Society of Professional Engineers, and past president of the Professional Engineers of Colorado, Boulder Chapter.

Brandon Kulik

Role: This panel member was chosen primarily for his NEPA and biology experience and expertise.
Affiliation: Kleinschmidt Associates

Mr. Brandon Kulik serves as a senior fisheries biologist at Kleinschmidt Associates. He received his M.S. degree in Aquatic Zoology from DePauw University in 1978, with his thesis focused on large river fish assemblages in the Ohio River and the effects of power generation and water quality on fish distributions. He has also received training in Fish Passageways and Diversion Facilities from the U.S. Fish and Wildlife Service.

Mr. Kulik has more than 32 years of experience in the design, execution, and reviews of environmental studies pertaining to fish passage, ecology, instream flow and aquatic habitat evaluations, and the bio-response of large river ecosystems to fish passage, habitat, and water quality changes. He has extensive dam and fish passage design experience in the Mohawk River of New York and the Saco and Kennebec Rivers of Maine, and has conducted radio telemetry and other tracking studies evaluating fish movement in the Narraguagus, Sheepscot, and Kennebec Rivers of Maine. Mr. Kulik has a strong working knowledge of flood risk management due to his involvement on interdisciplinary teams of engineers, hydrologists, and regulators evaluating flow control structures in New England, the mid-Atlantic, southeast, and mid-western states. Mr. Kulik has also been involved in wetland and riparian ecology, integrating botanical and riparian information for aquatic systems analyses for NOAA Atlantic Salmon recovery projects in Maine, and has worked on teams resolving terrestrial, wildlife, and botanical habitat issues for the East Branch Brandywine Pennsylvania study. He is familiar with USACE planning processes as well as NEPA requirements, developing alternative analyses to inform environmental decision-making, Federal licensing, and permitting processes for both the Saluda and Santee-Cooper Projects.

5. SUMMARY OF FINAL PANEL COMMENTS

The panel members agreed among one another on their "assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" (USACE, 2010; p. D-4) in the Revised Fargo-Moorhead FS document. Table 3 lists the 16 Final Panel Comment statements by level of significance. The full text of the Final Panel Comments is presented in Appendix A. The following statements summarize the Panel's findings.

Economics: The Panel found that the economic and construction cost analyses are sound and comprehensive. However, the cost of the fish passage facilities does not appear to be justified based on the limited time these facilities would be in operation. Additional analysis should be performed to determine the importance of fish passage during flood season. In addition, the use of the steady state hydraulic model for the metro area flood damages estimate is not fully justified and therefore calls into question the benefit estimation for the LPP.

Engineering: The Panel found that hydrologic, hydraulic, and geotechnical analyses are sound and comprehensive. The proposed project design is robust and resilient; however, the design capacity of the system could be exceeded by extreme flood events. The proposed design of the spoil piles could be improved by optimizing the maximum spoil pile height while considering side slope stability, thereby minimizing land area requirements. Also, the report does not identify whether the spoil piles could be used for agricultural purposes after completion of the construction. This could affect project real estate costs.

The flood risk management plan is complicated and depends on the timely and correct operation of the two gated structures controlling flows to the Red and Wild Rice Rivers in anticipation of major flood events. An operation plan needs to be developed to define the process for predicting major hydrologic events, responsibilities for gate operation, and long term maintenance and periodic testing items. In addition, provisions need to be made for operation in case of a power failure. A plan, along with assigned responsibilities, should be developed for real-time adjustments to the operation of the two gate systems during flood events.

Environmental: The Panel found that the environmental analyses are sound and comprehensive. However, the report does not address the effects of the project on amphibian and reptile fauna. The placement of baffles or protruding rock boulders on the bottom of the fish passages at the gate structures may result in entrainment and mortality due to high water velocities expected during tainter gate closure. The high velocities may also create downstream scour. In addition, the effect of water recession on fish escapement from the canal channel is not analyzed. Finally, contemporary survey data describing potential impacts to freshwater mussels during project construction are not provided.

Table 3. Overview of 16 Final Panel Comments Identified by the Revised Fargo-Moorhead FS IEPR Panel

Significance – High	
1	The potential risks, both mechanical as well as hydrologic, associated with the operation of the gates at the diversion control structures do not seem to be considered in the feasibility analysis.
Significance – Medium	
2	The risks and uncertainties associated with the performance of the hydraulic structures under dynamic conditions are not fully addressed.
3	The impacts of overtopping of the CR17 tieback levee under extreme flood conditions are not evaluated, and the related potential for increased damage and loss of life is not well defined.
4	The limitation of the maximum spoil pile height to 15 feet is not discussed or justified in the report.
5	The potential use of spoil piles for agricultural purposes, including those spoil piles that serve as levees, may impact real estate costs.
6	The assumption that the total sediment load will divide in proportion to the amount of water diverted may not be correct, and could have a negative impact on river morphology downstream of the diversions.
7	The current design of fish passages does not consider the effects of high flow velocity on the rock size used to protect against scour and fish collisions leading to an increase in mortality.
8	The risk to migrating fish due to the operating hydraulics of the proposed Red River control structure has not been fully considered.
9	The effect of water recession on fish escapement from the diversion channel has not been analyzed, and may impact fish mortality.
10	The report does not address the impact of project construction and operation on mussel populations.
11	The amphibian and reptile fauna have not been considered in the environmental impact analysis.
12	There appear to be inconsistencies and overstated benefits associated with the use of the steady Phase III hydraulic model to estimate expected annual damages in the metro area of the Red River.
Significance – Low	
13	Comparable hydrologic and hydraulic models and methods have not been used to develop the LPP and Federally Comparable Plan (FCP) and limit the ability to accurately differentiate the impacts of the alternatives.
14	The economic analyses of the future “with” and “without project” conditions provided in Appendix C and the Regional Economic Development section are inconsistent.
15	A sensitivity analysis has not been conducted to determine the flood fight success rate needed to make the LPP or the FCP infeasible.
16	Costs for individual features are not provided in the Total Project Cost Summary (TPCS), which impairs the ability to define annual project improvements.

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APPENDIX A

Final Panel Comments

on the

Revised Fargo-Moorhead FS

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Comment 1
The potential risks, both mechanical as well as hydrologic, associated with the operation of the gates at the diversion control structures do not seem to be considered in the feasibility analysis.
Basis for Comment:
For the purpose of the feasibility analysis, the Red River control structure gates were operated within the HEC-RAS model to maintain a set flow stage at the United States Geological Survey (USGS) gage at Fargo, North Dakota. The opening of the gates determines the amount of flow diverted towards the North Dakota diversion channel and as such directly affects the success of the project. The gates were operated to reduce the peak flow discharge in the river while impounding water upstream. Flow staging and storage rely on the appropriate functioning and operation of the gates during a flood. Increasing the number of smaller gates at the structure may make it possible to operate the gates more easily, since larger gates are more difficult to operate, and at the same time allow for some redundancy in the event of a failure and/or problems during a flood. Furthermore, the report does not make it clear (1) how the gates will be operated once the project is built and future flood events produce hydrographs that are different from the ones used for design purposes, and (2) who will be responsible for making these decisions. If the operation of the gates at the diversion control structures is subjected to risks that have not been fully evaluated (e.g., power failure, debris accumulation), the gates may be incapable of handling a flood event before they can be repaired or could even fail during a flood. Although incorporating additional gates would increase the ultimate cost of the structure, such an augmentation could provide more flexibility in the final design of the diversion control structure.
Significance – High:
Gate operation malfunction and subsequent repairs could adversely affect the success of the project, as they may be expensive and require more than one flood season to complete. In addition, the gates need to be operated properly during a flood in order for the staging and storing strategy to work successfully.
Recommendations for Resolution:
1. Conduct a detailed study that combines the unsteady HEC-RAS model with the gate operation algorithm and 3D Computational Fluid Dynamics (CFD) modeling of the control structures with the goal of developing “operation rules” that could be applied either manually or automatically to ensure the success of the project. The flood hydrology should be incorporated on a real time basis into the operation of the gates. 2. Include a discussion in the Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study (FMMFS) that clearly identifies the entity responsible for operation of the gate system. 3. Consider the possibility of having a larger number of smaller gates at the control structure that can be used to throttle the flow more effectively and that can be operated in case of emergency.

Comment 2
The risks and uncertainties associated with the performance of the hydraulic structures under dynamic conditions are not fully addressed.
Basis for Comment:
The design of the diversion and flow control structures, as well as the fish passages, was simplified for the purpose of the feasibility analysis. There is still uncertainty about how the hydraulic structures will perform under dynamic conditions (i.e., during a flood). For the purpose of the hydraulic modeling, the structures are represented as in-line structures, as explained in Appendix C. However, some of the proposed hydraulic structures are not conventional and do not have a design standard (e.g., the tributaries are intersected by the diversion channel in the Locally Preferred Plan (LPP); therefore there is a risk that they will not perform as expected. Such structures can become bottle-necks, affecting the partition of flows and reducing the conveyance of the diversion channel. There is also uncertainty concerning the design of the fish passage structures since their hydraulic performance was not tested for a wide range of flow conditions. Both physical and mathematical modeling could be used to assess the performance and operation of the hydraulic structures under dynamic conditions. Proper operation of the gates at the Red River control structure, including fish passage conditions, could improve performance of the hydraulic structures, and lowering of high stages could achieve further reduction in flood damage.
Significance – Medium:
A more detailed analysis of the performance and operation of the proposed unconventional hydraulic structures under dynamic conditions is required to understand how these structures will function.
Recommendations for Resolution:
1. Use physical and mathematical modeling to assess the performance and operation of the hydraulic structures under dynamic conditions (Abad et al., 2009). 2. Use the modeling results from the performance assessment noted in the first recommendation to generate rating curves for the hydraulic structures that can be incorporated in the hydrologic and hydraulic engineering design.

Literature cited

Abad, J.D., Waratuke, A., Barnas, C. and M.H. Garcia (2009). Hydraulic model study of canoe chute and fish passage for the Chicago River North Branch dam. World Environmental and Water Resources Congress, Great Rivers, Kansas City, Kansas.

Comment 3

The impacts of overtopping of the CR17 tieback levee under extreme flood conditions were not evaluated, and the related potential for increased damage and loss of life was not well defined.

Basis for Comment:

The CR17 tieback levee is the proposed levee associated with Storage Area 1. The FMMFS Main Report states that a "portion of the CR17 tieback levee would be at an elevation lower than the other tie-back levees in order to act as an emergency spillway for extreme events that exceed the 0.2-percent chance event design capacity of the project." (Paragraph 3.7.2). According to Hydraulic Structures Appendix F, paragraph F3.3.2, the CR17 tieback levee would have a maximum height of approximately 19 feet.

The report and appendices do not indicate that a dam breach evaluation has been performed for the failure of the CR17 levee under these conditions. Since the CR17 levee would essentially function as a dam, the hazard potential for this structure should be evaluated and defined. However, if further analysis indicates that there is potential loss of life associated with a breach of the CR17 tieback levee, the cost impacts associated with addressing these concerns would not have a significant impact on the benefit cost ratio (e.g., these costs would likely be on the order of $500,000 to $1,000,000, which is minor in comparison to the total project cost estimate).

Significance – Medium:

Overtopping of this levee under an extreme flood event (i.e., 0.2% flood event) could create a dynamic flood wave that would cause increased downstream damage and the potential for loss of life.

Recommendations for Resolution:

1. Revise the current report to indicate that the potential impacts associated with overtopping of the CR17 tieback levee will be evaluated during the final design. Include potential impacts such as downstream damage and the potential for loss of life.
2. Evaluate the impacts of a dam breach for the CR17 levee due to overtopping during final design stages. Include an assessment of potential downstream impacts and an evaluation of the failure characteristics of the CR17 levee under overtopping flows.
3. Incorporate an overflow spillway design in this levee section if the evaluation of the potential downstream hazard related to the dam breach for the CR17 levee is significant. This levee section would likely be sited in the areas of lower embankment height.

Comment 4

The limitation of the maximum spoil pile height to 15 feet is not discussed or justified in the report.

Basis for Comment:

The FMMFS Main Report describes the channel and spoil pile configurations, specifying that the maximum spoil pile height will be 15 feet (paragraph 3.6.2). This number is also cited in several places in the Geotechnical Appendix I, including in the tabulation in Table I-16. Although the discussion in paragraph I.6.6.8 evaluates the impact of the spoil piles upon stability in various reaches, it does not provide any justification for limiting the maximum spoil pile height to 15 feet and this height limitation appears somewhat arbitrary.

The combination of the wide diversion channel, flat slopes, and the large adjacent spoil piles requires the acquisition of 8,054 acres of valuable agricultural land, which will be the responsibility of the local sponsors (paragraph 3.14.2). Increasing the spoil pile heights above 15 feet could reduce the project footprint and thereby the overall real estate costs that will be borne by the local sponsors. The Panel recognizes that increased spoil pile heights must satisfy stability criteria; however, the FMMFS Main Report and Appendix I provide no evidence that stability evaluations were performed for spoil pile heights greater than 15 feet.

Significance – Medium:

The maximum spoil pile height limitation affects the amount of acreage necessary to purchase and therefore impacts the costs of the project.

Recommendations for Resolution:

1. Provide a narrative discussion in the FMMFS Main Report (paragraph 3.6.2) describing why the maximum spoil pile height has been limited to 15 feet.
2. Include a discussion in Appendix I if the maximum spoil pile height of 15 feet is a limitation associated with the stability of the channel and spoil pile slopes.
3. Conduct additional stability evaluations, if a spoil pile height greater than 15 feet can reasonably be incorporated into the project, that precede the final design stages of the project to optimize the configuration of the spoil piles and channel setbacks for each reach. If a higher spoil pile is technically feasible, then an incremental cost analysis should be completed to evaluate whether the cost savings in terms of increased real estate would offset any increased construction costs.

Comment 5

The potential use of spoil piles for agricultural purposes, including those spoil piles that serve as levees, may impact real estate costs.

Basis for Comment:

Neither the FMMFS Main Report nor any of the appendices describe whether farming will be allowed on the top of the spoil piles after the project is completed. On other projects such as the Breckenridge Diversion Channel and the Wild Rice - Felton Ditch Projects, topsoil obtained from beneath the spoil piles and from the channel excavation was spread over the top of the spoil piles to allow farming after completion of the respective projects. The land in the Fargo-Moorhead project area is generally very rich agricultural land. If the majority of project spoil piles could be configured to allow agricultural use, the overall real estate costs for the project would likely decrease.

The placement requirements (i.e., compaction) for the spoil pile material also may be changed by the use of spoil piles as levee sections. Figure 28 in the FMMFS Main Report shows that the water surface profile for the 500-year flood event will be above the natural ground surface for a significant amount of the diversion channel length. In these areas, the Panel assumes that the spoil piles will serve as a levee for extreme flood events. The function of the spoil piles as levees was not discussed or described in any of the sections of the Main Report or appendices. The use of spoil piles as levees may involve special treatment of the spoil piles. Note that the reaches where the spoil piles serve as levees may impose some limitations on the types of agricultural activities permissible.

Significance – Medium:

A decrease in project real estate acquisition costs may be realized if spoil piles can be utilized for agricultural purposes in addition to serving as levees.

Recommendations for Resolution:

1. Include a discussion of potential agricultural use of the spoil piles in the FMMFS Main Report.
2. Identify the sections of the spoil piles that serve as levees and discuss whether they require any special treatment or have restrictions placed on them.
3. Review the cost estimates for local and real estate acquisition to reflect the future potential use of spoil piles for agricultural purposes.

Comment 6
The assumption that the total sediment load will divide in proportion to the amount of water diverted may not be correct, and could have a negative impact on river morphology downstream of the diversions.
Basis for Comment:
It is assumed in the analysis that because all of the affected rivers appear to be dominated by the transport of fine suspended material, the diversion of a fraction of the river flow will divert a proportional fraction of the total sediment load transported as suspended sediment. However, this might not be the case because the amount of bedload diverted is usually larger than the proportional amount of water diverted. This phenomenon is known in the literature as the Bulle effect (Vanoni, 2006). The amount of bedload transported by different streams could affect the bed morphology upstream of hydraulic structures (e.g., weirs), as well as downstream of the diversions in the river. A reduced incoming sediment load could result in erosion, while a reduced sediment transport capacity could cause river bed accretion followed by an increase in flood stage.
Significance – Medium:
Analyzing the response of the river morphology upstream and downstream of the Red River control structure is required to understand of the project performance.
Recommendations for Resolution:
1. Analyze the sediment loads in the Red River to determine how much is transported in suspension and how much as bedload for a wide range of flow conditions (Garcia, 2008). 2. Use sediment rating curve to determine morphological response of the Red River downstream of the diversion structure. 3. Repeat analysis to assess effect of diversions on the morphology of tributaries.

Literature cited

Garcia, M.H. (ed.) (2008). ASCE Manual of Engineering Practice 110, Sedimentation Engineering: Processes, Measurements, Modeling, and Practice. Reston, Virginia. 1150 pp.

Vanoni, V.A. (ed.) (2006). Sedimentation Engineering: Classic Edition. Reston, Virginia. 418 pp.

Comment 7
The current design of fish passages does not consider the effects of high flow velocity on the rock size used to protect against scour and fish collisions leading to an increase in mortality.
Basis for Comment:
A system of riffles and pools covered by rocks and boulders to protect against erosion is incorporated in the design of the fish passages (Rodriguez et al., 2002). The combined operation of fish passages and drop structures could result in high flow velocities inside the fish passage and associated fish mortality due to impact against the large-sized rock and boulders used to create riffles and to protect against scour. Fish injury or mortality may occur when large, heavy fish collide with hard surfaces or when small fish are entrained in shear zones (Bell, 1990). Further analysis may identify fishway engineering design elements that can be refined to avoid a potential increase on fish mortality, and prevent damage to the fish passage structure (Bell and DeLacey, 1972).
Significance – Medium:
The current design of fish passages to protect against structural damage due to scour induced by high flow velocity could lead to an increase in fish mortality.
Recommendations for Resolution:
1. Conduct a study that uses a 3D CFD model to compute flow velocities for different discharges in order to determine the minimum size of rock needed to prevent scour of the fish passage while minimizing fish damage during high flow events (Abad et. al., 2009). 2. Analyze the potential for fish injury or mortality under the hydraulic conditions modeled. 3. Optimize the design of the fishway to produce flow velocities that are appropriate for fish passage and do not damage the structure (Caisley and Garcia, 1999).

Literature cited

Abad, J.D., Waratuke, A., Barnas, C. and M.H. Garcia (2009). Hydraulic model study of canoe chute and fish passage for the Chicago River North Branch dam. World Environmental and Water Resources Congress, Great Rivers, Kansas City, Kansas.

Bell, M.C. and A.C. DeLacy (1972). A compendium of the survival of fish passing through spillways and conduits. Fisheries Engineering Research Division, U.S. Army Corps of Engineers, Portland, Oregon. 121 pp.

Bell, M.C. (1990). Fisheries handbook of engineering requirements and biological criteria. Fisheries Engineering Research Division, U.S. Army Corps of Engineers, Portland, Oregon.

Caisley, M.E. and M.H. García (1999). Canoe chutes and fishways for low-head dams: literature review and design guidelines. Hydraulic Engineering Series No. 60 (UILU-99-2001), University of Illinois at Urbana-Champaign. Civil Engineering Studies. January.

Rodríguez, J. F., C.M. García, and M.H. García (2002). Mean flow and turbulence characteristics in pool-riffle structures. Hydraulic Measurements & Experimental Methods, EWRI-IAHR, Estes Park, Colorado. July.

Comment 8
The risk to migrating fish due to the operating hydraulics of the proposed Red River control structure has not been fully considered.
Basis for Comment:
The design of the Red River control structure calls for the operation of three 40-foot wide gates to reduce the flow into the protected area. The design also calls for the use of baffles and rip-rap rock to create flow diversity, naturalized flow conditions, and prevent scour downstream of the gates. The Panel is concerned that the FMMFS Main Report does not address a potential area of concern: under certain gate openings flow velocity could reach values of up to 30 ft/s, resulting in an increased risk for fish mortality if they become entrained by the flow under the gate. Fish entrained through the gates cannot maintain swimming behavior, and therefore may be subject to collision or hydraulic stress injury or mortality when passing through these structures at high velocities (Bell, 1990; Bell and De Lacey, 1972).
Significance – Medium:
The placement of baffles or protruding rock on the bottom of the river as diversion control structures may result in entrainment and mortality of fish due to high water velocities that often occur when the Tainter gates are closed and flow takes place through the bottom gap.
Recommendations for Resolution:
1. Analyze the frequency and duration of operating hydraulics that could result in fish mortality during periods of fish migration. 2. If the analysis shows a significant risk to fish, perform a study using a 3D CFD model to assess the minimum size of rock needed to prevent scour of the area downstream of the gates, as well as the best baffle design for dissipating energy and creating flow diversity while minimizing potential fish damage (Abad et al., 2009).

Literature cited

Abad, J.D., Waratuke, A., Barnas, C. and M.H. Garcia (2009). Hydraulic model study of canoe chute and fish passage for the Chicago River North Branch dam. World Environmental and Water Resources Congress, Great Rivers, Kansas City, Kansas.

Bell, M.C. (1990). Fisheries handbook of engineering requirements and biological criteria. Fisheries Engineering Research Division, U.S. Army Corps of Engineers, Portland, Oregon.

Bell, M.C. and A.C. DeLacy (1972). A compendium of the survival of fish passing through spillways and conduits. Fisheries Engineering Research Division, U.S. Army Corps of Engineers, Portland, Oregon. 121 pp.

Comment 9
The effect of water recession on fish escapement from the diversion channel has not been analyzed, which may impact fish mortality.
Basis for Comment:
The FMMFS thoroughly analyzes the potential for fish stranding in the flood plain, but only discusses the potential for fish stranding in the diversion channel as a function of water level recession: "As water levels decrease, fish would be expected to respond by migrating downstream out of the diversion channel" (p.255). The FMMFS also states, without supporting documentation: "While it is possible that a few larger fish could be lost in isolated pools within the diversion channel, it is believed that this would not be a significant issue during project operations." (p. 255). The Panel is concerned that these assumptions overlook that the fact that debris such as large trees and other dislodged alluvial or geologic material trapped in the diversion channel may also accumulate in the diversion channel, blocking parts of the low flow channel and thus preventing the escape of fish. Fish stranding during activities such as impoundment draining (done for dam maintenance or removal) frequently requires fish to be rescued to avoid stranding mortality. For example, a recent dam removal in a shallow riverine impoundment with stream channel slopes and geometry similar to the proposed diversion channel resulted in fish entrapped during a gradual drawdown, which required implementing fish rescues and monitoring to avoid impacting this resource (Fort Halifax Dam Removal, Winslow, Maine; Sargent, 2008).
Significance – Medium:
Failure to address the effect of water recession on fish escapement may cause (1) overestimation of the ability of the diversion to evacuate fish and therefore provide habitat connectivity, or (2) overlooking design and operation/maintenance considerations needed to provide the desired level of fish passage.
Recommendations for Resolution:
1. Review the engineering design of the diversion channel relative to fish entrapment by accumulating debris, and also the generalized FMMFS statement that this would not be a significant issue. 2. If review indicates that the risk of fish stranding in the diversion channel is high, include design alternatives, and/or rescue protocols, or a monitoring and adaptive management strategy to address the issue of fish stranding in the diversion channel.

Literature cited

Sargent Corp. (2008). Fort Halifax Dam Removal, Winslow, Maine. http://www.sargent-corp.com/public-works/46-fort-halifax-dam-removal-winslow-me.html.

Comment 10
The report does not address the impact of project construction and operation on mussel populations.
Basis for Comment:
The FMMFS Main Report discusses mussels briefly (Section 4.2.1.8.2), but does not address the biological requirements of freshwater mussels. This project could have a direct effect on mussel habitat (i.e., stream channel morphology and substrates) and an indirect effect on populations, as mussels rely on fish movements for colonization. In-river construction projects that could result in substrate disturbance, or temporary or chronic dewatering of stream habitat, can result in mussel mortality. A mussel protection or monitoring plan may be advisable to reduce impacts to these aquatic animals (Dunn, et al., 2000; Wailer, et al., 1998). Aspects of project operation that affect fish passage and habitat connectivity can also impact mussel populations. Fish are key vectors for distributing mussel larvae, and thereby serve an important role in maintaining mussel populations within an ecosystem. Some mussel species even rely on a specific fish species as vector host. Although the fish passage provisions of this project can benefit freshwater mussel populations by enhancing habitat connectivity, Section 5 of the FMMFS Main Report does not discuss the related potential benefits or impacts to mussel populations.
Significance – Medium:
Omission of an analysis and plan to address impacts and benefits to mussels will limit the understanding of the project impacts.
Recommendations for Resolution:
1. Discuss whether the locally indigenous fish species are host species for applicable mussel species. 2. Analyze how changes to stream channel habitat will affect both fish host species and applicable mussel species, using existing project data. Account for both during project construction and project operation. 3. Analyze fish passage as it affects migration for critical host fish species, based on available literature and input from local fishery agency staff. Analyze how proposed fish passage conditions will benefit mussel colonization.

Literature cited

Dunn, H. L., B.E. Sietman, and D.E. Kelner (2000). Evaluation of recent Unionid (Bivalvia) relocations and suggestions for future relocations and reintroductions. Proceedings of the First Freshwater Mollusk Conservation Society Symposium, Chattanooga, Tennessee, pp 169-183.

Wailer, D.L., J.J. Rach, W.G. Cope, and J.A. Luom (1993). A sampling method for conducting relocation studies with freshwater mussels. J. Freshwater Ecol., 8:397-399.

Comment 11
The amphibian and reptile fauna have not been considered in the environmental impact analysis.
Basis for Comment:
The Panel is concerned that amphibians and reptile species that live in the project area and rely on habitat that will be altered by this project are not acknowledged or discussed in Section 4.2 of the FMMFS Main Report. No potential impacts are identified, and/ or mitigation strategies discussed in Section 5 of the FMMFS Main Report. The Panel notes that the FMMFS Main Report documents that floodplain wetlands will be altered by this project and tributary channel diversions are proposed that will change or eliminate certain stream reaches. Snapping turtles, painted turtles, and map turtles, which may inhabit the project area, rely on aquatic riverine habitat for feeding and reproduction. The proposed alterations to tributaries and the Red River could affect this habitat use and local populations. Tree frogs and Blanding's turtles rely on wetland-habitat for feeding, shelter, reproduction, and overwinter hibernation functions (Minnesota Department of Natural Resources). Increases, decreases, or changes to wetland habitat resources can affect the local abundance and distribution of these species.
Significance – Medium:
Without knowing how the proposed alterations to tributaries and the Red River could affect the habitat use and local populations of amphibian and reptile fauna, it is possible that potential mitigation options are being overlooked.
Recommendations for Resolution:
1. Identify the indigenous reptiles and amphibian species that inhabit the project area and require aquatic and wetland habitat as part of their life cycle; include this information in Section 4 of the FMMFS Main Report. 2. Analyze project impacts on amphibian and reptilian habitat requirements using the information on changes to wetland and riverine habitats already documented in the FMMFS Main Report, as well as other studies found in the literature. 3. Include a discussion of the impact analysis in Section 5.2 of the FMMFS Main Report to add support to the proposed mitigation strategies.

Literature cited

Endangered, Threatened, and Special Concern Species of Minnesota: Blanding's Turtles. Environmental Review Fact Sheet Series, Minnesota Department of Natural Resources, Division of Ecological Resources. Updated March 2008. http://files.dnr.state.mn.us/natural_resources/animals/reptiles_amphibians/turtles/blandings_turtle/factsheet.pdf

Comment 12
There appear to be inconsistencies and overstated benefits associated with the use of the steady Phase III hydraulic model to estimate expected annual damages in the metro area of the Red River.
Basis for Comment:
Additional information is needed in Appendix C to confirm how the hydrology was incorporated in the damage estimates to understand whether the estimates of damages in the metro area of the Red River are reasonable. Although the first paragraph in Appendix C (Economics, p. C-24) states that the new hydrologic estimates include the use of "wet" period flows for both the metro and non-metro areas, the water surface profiles (WSPs) were developed using the steady Phase III hydraulic model for the metro area, and the unsteady model for the non-metro areas. The Panel is concerned that the WSPs are not being consistently used to estimate damages. Furthermore, there is little discussion of the legitimacy of adopting this approach or its implications. The issue is further compounded (p. C-60) by explaining that when the steady model results are used in the metro areas and the unsteady results in the non-metro areas, the model overstates Equivalent Expected Annual Damage (EEAD) and Equivalent Expected Annual Benefit (EEAB) in cross-sections and understates EEAD in storage cells. The overall result is to overstate benefits. The Appendix further states, "It is uncertain how sensitive the [National Economic Development] NED identification and plan selection are to this issue." If the NED identification and plan selection might be sensitive to this issue, then more clarification is needed.
But Significance – Medium:
Further discussion of hydraulic modeling and associated overestimate of project benefits is required to determine if the NED identification and alternative selection is sensitive to the use of the steady Phase III hydraulic model for the metro areas.
Recommendations for Resolution:
1. Provide a more detailed explanation in Appendix C of the theoretical rationale for using two different models to estimate damages. 2. Conduct an additional sensitivity analysis to demonstrate that the results of using the unsteady model for the metro area do not affect the outcome of the entire study.

Comment 13
Comparable hydrologic and hydraulic models and methods have not been used to develop the LPP and Federally Comparable Plan (FCP) and limit the ability to accurately differentiate the impacts of the alternatives.
Basis for Comment:
As presented in Appendix C, upstream staging and storage were used to estimate the impacts of the LPP in Phase 4 with improved versions of hydrologic models for the tributaries, as well as unsteady hydraulic models for flood routing. However, it would seem that the same approach was not used to assess the impacts of the FCP. Given that the improved hydrologic estimates for the flow contribution of the tributaries and the storage upstream were not used for the analysis of the FCP, it is not possible to compare the FCP results with those of the LPP. The two project alternatives were assessed using different approaches.
Significance – Low
Comparable procedures and methods for analyzing the project alternatives are required to ensure that the project objectives are achieved and so that the benefits and impacts of the LPP and FCP can be estimated with the same level of accuracy and uncertainty.
Recommendations for Resolution:
1. Perform the Phase 4 hydrologic and unsteady hydraulic model analysis, which includes upstream staging and storage for the FCP. 2. Estimate the impacts associated with the FCP, including the possibility of storage upstream of the Red River Control Structure using the improved hydrologic and hydraulic models. 3. Compare the results with those obtained for the LPP.

Comment 14
The economic analyses of the future "with" and "without project" conditions provided in Appendix C and the Regional Economic Development section are inconsistent.
Basis for Comment:
In Appendix C, the future "with" and "without project" conditions assume the same levels of growth. i.e., 266 acres per year (p. C-34, Section 3.7). However, in the Regional Economic Development Section (p. C-62), a survey of business owners revealed that, in the event of a failed flood fight, companies would leave the region. If these two statements are considered consistent, they imply that in the "without project" scenario, no flood fight failure is anticipated, but this contradicts the discussion of flood fights. The growth scenario should be explained more completely, and if the "with" and "without" scenarios are to be the same, a rationale should be provided. Additional information is now available from Census 2010, and has been used in the Other Social Effects Analysis (Appendix D). This information could improve the analysis of the population size and support later assertions of growth (p. C-13). Metrics for benefits and costs all depend upon a solid understanding of the baseline, so the future baseline should be supported with a little more detail.
Significance – Low:
Updated information is needed to more fully define the "with" and "without project" growth scenarios.
Recommendations for Resolution:
1. Include 2010 Census data and explain why the data depart or support the "without project" baseline assumptions of growth. 2. Explain the methodology for using the same growth scenario for the "with" and "without project" assumptions.

Comment 15

A sensitivity analysis has not been conducted to determine the flood fight success rate needed to make the LPP or the FCP infeasible.

Basis for Comment:

A discussion of uncertainty and risk requires a feasibility analysis of flood fight success. In analyzing the ND35K option, a 30% flood fight success rate was found to make the project unfeasible, and a 70% flood fight success rate was found to make the NED plan unfeasible (Main Report, p. 109). However, no calculation was included for the flood fight success rate needed to make the LPP (modified ND35K) or the FCP unfeasible. Appendix O (p. O-9) states that the Vertical Team and the Agency Team Review (ATR) concluded that a sensitivity analysis should be conducted on this issue to provide decision makers with the information. Given that the LPP is a modified North Dakota alignment, the Panel speculates that the level of flood fight success might be closer to the 30 % flood fight success rate needed to make the LPP unfeasible. For the NED, it is not clear whether the NED in the analysis was the original MN40K or the Short MN40K.

The discussion suggests that the sensitivity analysis may have been done with earlier hydrologic results. This analysis would be more complete if current hydrology were used on current alternatives to demonstrate how the results would change.

The ATR and Vertical Team did not include flood fight as a benefit in the "without project" scenario. This is potentially confusing in understanding the context of the flood damage estimates and benefit calculations. The sensitivity analysis should clarify how the flood fight might fit in the benefit/cost calculations.

Significance Level: Low

The ATR directive to conduct a sensitivity analysis exploring how flood fighting might affect the benefit/cost analysis does not currently provide decision makers with much information because it does not relate to the LPP and the FCP alternatives.

Recommendations for Resolution:

1. Conduct a sensitivity analysis for the LPP and FCP to demonstrate how the benefit/cost ratio would change if flood fighting were to be counted.
2. Demonstrate the highest level of flood fight success that will still make the project feasible.
3. Apply the current hydrology to estimate the analysis provided in Recommendation 1.
4. Provide a few sentences of explanation for the sensitivity analysis.
5. Provide more explanation in the Main Report or in Appendix C about why the ATR and Vertical Team decided not to count flood prevention benefits associated with the flood fight in the "without project" scenario.

Comment 16
Costs for individual features are not provided in the Total Project Cost Summary (TPCS), which impairs the ability to define annual project improvements.
Basis for Comment:
The previous version of the Fargo-Moorhead DFR/EIS included individual improvement costs for each project facility after the TPCS, costs for individual features such as an individual bridge or channel, and where they were located. The project funding stream is variable and does not necessarily follow the anticipated cash flow basis due to changes outside the control of the project. Including these costs allows project planners to modify anticipated future construction budgets by adding or subtracting project line items in any given year. If the TPCS does not include individual feature costs, the reach of improvements constructed in a given year are difficult to define if there are changes in the funding stream.
Significance – Low:
Individual cost features are needed to make changes in the budget for a given year due to future funding constraints.
Recommendations for Resolution:
1. Include cost sheets for individual project facilities in a manner similar to those presented in the previous version of the Fargo-Moorhead DFR/EIS to assist planners in anticipating future construction modifications.

APPENDIX B

Final Charge to the Independent External Peer Review Panel
as
Submitted to USACE on May 9, 2011

on the

Revised Fargo-Moorhead FS

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Final Charge Questions and Guidance to the Peer Reviewers
for the
Revisions to the Fargo-Moorhead
Metropolitan Flood Risk Management Feasibility Study Report,
North Dakota and Minnesota

BACKGROUND

The Fargo-Moorhead metropolitan area is located on the Red River of the North, but the Wild Rice, Sheyenne, Maple, and Rush Rivers in North Dakota and the Buffalo River in Minnesota also cross the study area. This area has a relatively high risk of flooding, usually occurring as a result of spring snowmelt, although summer rainfall events have also caused significant damages. The Red River of the North has exceeded the National Weather Service flood stage of 17 feet in 52 of the past 108 years, and every year from 1993 through 2010. The study area is between the Wild Rice River, the Sheyenne River, and the Red River of the North; interbasin flows complicate the hydrology of the region and contribute to extensive flooding. Average annual flood damages in the Fargo-Moorhead metropolitan area are currently estimated at over $195.9 million.

A draft feasibility report recommending a project to address flood risk management, ecosystem restoration, and recreation needs of the study area was completed by the U.S. Army Corps of Engineers (USACE) St. Paul District in February 2010. An IEPR of the draft feasibility report, Draft Environmental Impact Statement, and technical appendices was initiated in February 2010, and the documents to be reviewed were provided to the expert panel in March 2010. The Final IEPR Report was completed in May 2010 and the USACE/IEPR panel comment and response process was completed in July 2010.

Subsequent higher level review within USACE resulted in substantive revisions to the documents that had undergone IEPR. Generally these revisions do not affect the recommendations of the study report, but pertain more to their associated impacts. These revisions are considered sufficiently extensive to warrant an IEPR of those changes.

OBJECTIVES

The objective of this work is to conduct a follow-on independent external peer review (IEPR) of the Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study Report (hereinafter: Fargo-Moorhead Follow-On IEPR) in accordance with the Department of the Army, USACE, Water Resources Policies and Authorities' *Civil Works Review Policy* (EC 1165-2-209) dated January 31, 2010, and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* released December 16, 2004.

Peer review is one of the important procedures used to ensure that the quality of published information meets the standards of the scientific and technical community. Peer review typically evaluates the clarity of hypotheses, validity of the research design, quality of data collection procedures, robustness of the methods employed, appropriateness of the methods for the

hypotheses being tested, extent to which the conclusions follow from the analysis, and strengths and limitations of the overall product.

The purpose of the IEPR is to assess the "adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" (EC 1165-2-209; p. D-4) for the revisions to the Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study Report. The IEPR will be limited to technical review and will not involve policy review. The IEPR will be conducted by the same panel of subject matter experts (i.e., IEPR panel members) who performed the previous IEPR of the study report and have extensive experience in engineering, economics, and environmental issues relevant to the project. They should also have experience applying their subject matter expertise to flood risk management.

The Panel will be "charged" with responding to specific technical questions as well as providing a broad technical evaluation of the overall project. Per EC 1165-2-209, Appendix D, review panels should identify, explain, and comment upon assumptions that underlie all the analyses, as well as evaluate the soundness of models, surveys, investigations, and methods.

The charge questions will mainly be focused on the proposed plan and the impacts of the proposed plan (primarily upstream and downstream impacts, fish connectivity, geomorphology, possible ice issues, and general environmental impacts). Review panels should be able to evaluate whether the interpretations of analysis and the conclusions based on analysis are reasonable. Reviews should focus on assumptions, data, methods, and models. The panel members may offer their opinions as to whether there are sufficient analyses upon which to base a recommendation.

DOCUMENTS PROVIDED

The following is a list of documents and reference materials that will be provided for the review. **The documents and files presented in bold font are to be reviewed**. All other documents are provided for reference.

Supplemental Draft Feasibility Report and Environmental Impact Statement, Fargo-Moorhead Metropolitan Area, Flood Risk Management, April 2011

- **Appendix A: Hydrology**
- **Appendix B: Hydraulics**
- **Appendix C: Economics**
- **Appendix D: Other Social Effects**
- Appendix E: Cultural Resources
- **Appendix F: Environmental**
- Appendix G: Real Estate
- Appendix H: Credit to Existing Levees
- **Appendix I: Geotechnical Engineering**
- **Appendix J: Structural**

- Appendix K: Civil Engineering
- **Appendix L: Cost Engineering**
- Appendix M: Recreation and Aesthetics
- Appendix N: Not Used
- Appendix O: Plan Formulation
- Appendix P: Non-Structural
- Appendix Q: Public Involvement and Coordination
- Appendix R: DEIS Public and Private Comments Received
- Appendix S: DEIS Public and Private Summarized Comments and Corps Responses
- **Plan Plates**
- **AE Appendix ("Attachment 5 – Consultant's Report")**
- **Fargo-Moorhead Metro Feasibility Study History and Context for April 2011 IEPR Review**
- USACE guidance *Civil Works Review Policy* (EC 1165-2-209) dated January 31, 2010
- CECW-CP Memorandum dated March 31, 2007
- Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* released December 16, 2004.

SCHEDULE

TASK	ACTION	DUE DATE
Conduct Peer Review	Battelle sends review documents to IEPR Panel	5/12/2011
	Battelle/IEPR Panel kick-off meeting	5/12/2011
	USACE/Battelle/Panel kick-off meeting	5/12/2011
	Battelle and potentially lead panel member attendance at CWRB (Confirming Option)	9/23/2011
	Panel members complete their individual reviews	6/6/2011
Prepare Final Panel Comments and Final IEPR Report	Battelle provides Panel merged individual comments and talking points for Panel Review Teleconference	6/8/2011
	Battelle convenes Panel Review Teleconference	6/9/2011
	Battelle provides Final Panel Comments directive to Panel	6/10/2011
	Panel members provide draft Final Panel Comments to Battelle	6/17/2011
	Battelle provides feedback to Panel on draft Final Panel Comments; Panel provides revised draft Final Panel Comments per Battelle feedback (iterative process)	
	Panel members finalize Final Panel Comments	6/28/2011
	Battelle provides Final IEPR Report to Panel for review	6/30/2011
	Panel provides comments on Final IEPR Report	7/1/2011
	*Battelle submits Final IEPR Report to USACE	7/7/2011
Comment Clarification and Response	Battelle inputs Final Panel Comments to DrChecks; Battelle provides Comment Response template to USACE	7/11/2011
	Battelle holds teleconference with Panel to review the Comment Response Process (if necessary)	7/11/2011
	USACE provides draft Evaluator Responses to Battelle	7/21/2011
	Battelle provides the draft Evaluator Responses to the Panel	7/22/2011
	Panel members provide Battelle with draft comments on draft Evaluator Responses (i.e., draft BackCheck Responses)	7/27/2011
	Battelle holds teleconference with Panel to discuss draft BackCheck Responses	7/27/2011
	Battelle convenes teleconference with Panel and USACE to discuss Final Panel Comments, and draft responses	7/28/2011
	USACE inputs final Evaluator Responses in DrChecks	8/3/2011
	Battelle provides Evaluator Responses to Panel	8/4/2011
	Panel members provide Battelle with final BackCheck Responses	8/9/2011
	Battelle inputs the Panel's BackCheck Responses in DrChecks	8/11/2011
	*Battelle submits pdf printout of DrChecks project file	8/11/2011

CHARGE FOR PEER REVIEW

Members of this IEPR Panel are asked to determine whether the technical approach and scientific rationale presented in the Revisions to the Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study Report, North Dakota and Minnesota, are credible and whether the conclusions are valid. The Panel is asked to determine whether the technical work is adequate, competently performed, properly documented, satisfies established quality requirements, and yields scientifically credible conclusions. The Panel is being asked to provide feedback on the economic, engineering, environmental resources, and plan formulation. The panel members are not being asked whether they would have conducted the work in a similar manner.

Specific questions for the Panel (by report section or Appendix) are included in the general charge guidance, which is provided below.

General Charge Guidance

Please answer the scientific and technical questions listed below and conduct a broad overview of the Revisions to the Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study Report, North Dakota and Minnesota. Please focus your review on the review materials assigned to your discipline/area of expertise and technical knowledge. Even though there are some sections with no questions associated with them, that does not mean that you cannot comment on them. Please feel free to make any relevant and appropriate comment on any of the sections and appendices you were asked to review. In addition, please note the following guidance. Note that the Panel will be asked to provide an overall statement related to 2 and 3 below per USACE guidance (EC 1165-2-209; Appendix D).

1. Your response to the charge questions should not be limited to a "yes" or "no." Please provide complete answers to fully explain your response.
2. Assess the adequacy and acceptability of the economic and environmental assumptions and projections, project evaluation data, and any biological opinions of the project study.
3. Assess the adequacy and acceptability of the economic analyses, environmental analyses, engineering analyses, formulation of alternative plans, methods for integrating risk and uncertainty, and models used in evaluating economic or environmental impacts of the proposed project.
4. If appropriate, offer opinions as to whether there are sufficient analyses upon which to base a recommendation.
5. Identify, explain, and comment upon assumptions that underlie all the analyses, as well as evaluate the soundness of models, surveys, investigations, and methods.
6. Evaluate whether the interpretations of analysis and the conclusions based on analysis are reasonable
7. Please focus the review on assumptions, data, methods, and models.

Please **do not** make recommendations on whether a particular alternative should be implemented, or whether you would have conducted the work in a similar manner. Also please

do not comment on or make recommendations on policy issues and decision making. Comments should be provided based on your professional judgment, **not** the legality of the document.

1. If desired, panel members can contact one another. However, panel members **should not** contact anyone who is or was involved in the project, prepared the subject documents, or was part of the USACE Independent Technical Review.
2. Please contact the Battelle Project Manager (Julian DiGialleonardo, digialleonardoj@battelle.org) or Program Manager (Karen Johnson-Young, johnson-youngk@battelle.org) for requests or additional information.
3. In case of media contact, notify the Battelle Program Manager immediately.
4. Your name will appear as one of the panel members in the peer review. Your comments will be included in the Final IEPR Report, but will remain anonymous.

Please submit your comments in electronic form to Julian DiGialleonardo, digialleonardoj@battelle.org, no later than June 6, 2011, 10 pm EDT.

Independent External Peer Review
Revisions to the Fargo-Moorhead Metropolitan Flood Risk Management Feasibility Study Report, North Dakota and Minnesota

Final Charge Questions

GENERAL QUESTIONS

1. Does the analysis of the recommended plan adequately address redundancy, resiliency, or robustness for a concept design?

2. Are the quality and quantity of the surveys, investigations, and engineering sufficient for a concept design?

3. Comment on the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used.

4. Are the interpretations of analysis and conclusions based on the analysis reasonable?

5. Are the uncertainties in the data and analyses, and associated risks, adequately addressed and described to support the decision being made?

SECTION 1.0 – STUDY INFORMATION

No questions.

SECTION 2.0 – NEED FOR AND OBJECTIVES OF ACTION

No questions.

SECTION 3.0 – ALTERNATIVES

Section 3.1 Plan Formulation Rationale

No questions.

Section 3.2 Management Measures and Preliminary Plans

No questions.

Section 3.3 Feasibility Phase 1

No questions.

Section 3.4 Feasibility Phase 2, Screening #1

No questions.

Section 3.5 Phase 2, Screening #2

No questions.

Section 3.6 Feasibility Phase 3

6. Comment on whether the adjustments made during feasibility phase 3 are accurate, realistic, and compressive.

Section 3.7 Feasibility Phase 4

7. Comment on whether the discussion of mitigation options is accurate, realistic, and comprehensive.

Section 3.8 Comparison of Alternatives

No questions.

Section 3.9 Plan Selection

No questions.

Section 3.10 Risk and Uncertainty

8. Comment on the use of non-standard hydrologic methods to account for climate change variability.

9. Comment on the completeness of the discussion of risk and uncertainty.

10. Comment on the extent to which the costs are consistent with and justified by the detailed analysis

11. Are the cost and schedule risks accurate and realistic?

Section 3.11 Description of the MN35K Plan (Federally Comparable Plan)

No questions.

Section 3.12 Description of the Tentatively Selected Plan

12. Comment on whether the component features are adequately designed and sufficient for satisfying the study objectives.

13. Comment on whether the discussion of mitigation options and environmental commitments is accurate, realistic, and comprehensive.

14. Comment on the major assumptions used in the evaluation of the alternatives.

15. Comment if the engineering challenges associated with the tentatively recommended plan have been adequately assessed.

Section 3.13 Implementation Requirements

16. Are the obstacles for implementing the tentatively selected plan clear identified?

SECTION 4.0 – AFFECTED ENVIRONMENT

Section 4.1 Environmental Setting of the Study Area

17. Does the information presented in this report support geographic scope of analysis? Why or why not?

Section 4.2 Significant Resources

18. Comment on the accuracy of the predictions for future wetland acreage under the baseline or without-project conditions relative to current laws, regulations, and conditions.

Section 4.2.1 Natural Resources

19. Comment on the comprehensiveness of the variables incorporated into this section.

20. Comment on whether rainfall patterns and other climate change-related impacts have been considered thoroughly.

Section 4.2.2 Cultural Resources

No questions.

Section 4.2.3 Socioeconomic Resources

No questions.

SECTION 5.0 – ENVIRONMENTAL CONSEQUENCES

Section 5.1 Environmental Evaluation Methodology

No questions.

Section 5.2 Effects on Significant Resources

21. Comment on whether the direct, indirect, and cumulative effects are adequately evaluated and quantified in this section for the LPP and FCP.

22. Comment on the accuracy of the predictions for future wetland acreage under the baseline, or without project conditions relative to current laws, regulations and conditions.

23. Comment on the adequacy of the descriptions for the recreational opportunities presented by the alternatives.

24. Comment on the thoroughness of the transportation considerations described.

25. Comment on the predicted impact of each alternative on wetland acreage in the project area.

26. Comment on whether all potential fisheries and aquatic habitat that may be impacted by each of the alternatives has been identified.

27. Comment on the predicted impact of each alternative on fish passage in the project area.

28. Comment on the predicted impacts of each alternative on the endangered species present in the project area.

29. Comment on the approach used for geomorphology assessment, section 5.2.1.3.

Section 5.3 Controversy

No questions.

Section 5.4 Cumulative Effects

No questions.

Section 5.5 Mitigation and Adaptive Management

30. Comment on the mitigation as to accuracy and comprehensiveness to address impacts of the tentatively selected plan.

SECTION 6.0 – PUBLIC INVOLVEMENT, REVIEW AND CONSULTATION

No questions.

SECTION 7.0 – LIST OF PREPARERS

No questions.

SECTION 8.0 – RECOMMENDATION

No questions.

APPENDIX A: HYDROLOGY

Since the last IEPR review, the hydrology Appendix has been expanded to incorporate the recommendations of the Expert Opinion Elicitation (EOE). In support of hydraulic modeling efforts, the study limits have been modified to include the Red River Basin between Hickson, North Dakota and Emerson, Manitoba, Canada.

USACE carried out hydrological analysis for the Fargo-Moorhead Metro Feasibility Study (FMMFS) in four phases. During the first IEPR review, reviewers assessed the first phase analysis along with the recommendations made by the EOE (Appendices A-1a and A-1b). Since that review, USACE engineers have updated the analysis to incorporate the EOE recommendations and have worked to provide hydrological analysis in support of expanded hydraulic modeling from Hickson, North Dakota to Emerson, Manitoba, Canada. This expanded analysis can be found in Appendices A-1c, A-2, A-3, 4a, and 4b of the Fargo Moorhead Feasibility Study.

31. Comment on how the EOE recommendations were incorporated into the hydrological analysis. Were their recommendations adopted appropriately?

32. Comment on the validity of the methods used to estimate flows (coincidental, instantaneous annual peak flows, and mean daily) for analysis.

33. Comment on the assumptions used in generating frequency analysis and balanced hydrographs throughout the basin (coincidental and annual instantaneous).

34. Comment on the methods used to analyze the complexities associated with local area flow, reservoirs, breakout flows, hydrologic routing, and flood plain storage throughout the study area. Where appropriate, were models utilized and is analysis reflective of true basin conditions?

35. Comment on the assumptions made/appropriateness/validity of using coincidental flow-frequency analysis and coincidental balanced hydrographs to determine the companion flows to Red River mainstem frequency events along the tributaries.

APPENDIX B: HYDRAULICS

Since the last IEPR, the hydraulic design has changed from a steady flow analysis to an unsteady flow analysis to address downstream stage impacts due to the diversion project

36. Comment on the plan for staging water upstream to reduce downstream stage impacts and the risk and uncertainty involved in operation, ice effects, and geomorphologic changes.

37. Comment on the suitability of unsteady HEC-RAS to model flow breakouts and flow through a series of connected storage areas.

38. Comment on the benefits of having Storage Area 1 inside the area of protection.

39. Comment on the plan for sending water west out of the staging areas for events larger than the 0.2% flood event.

40. Comment on the soundness and thoroughness of the engineering calculations and modeling utilized.

41. Comment on the validity of the technical assumptions used to recommend the alignment of the low flow, diversion flow, and tributary channels.

42. **(PLAN PLATES)** Please describe whether the utility of the channel diversion and levee profiles is clearly stated and supported and if the profiles are fit-for-purpose in terms of content and level of detail.

APPENDIX C: ECONOMICS

43. Comment on the methodology for the inventory of existing economic conditions and its use to determine future with- and without-project conditions
44. Comment on the evaluation of expected annual and equivalent annual damage, benefits, and costs
45. Comment on the definition of uncertainties and the analysis/discussion of project performance.

46. Comment on the validity of assumptions in Section 3.3.3.2 of Appendix C (Economics) for using the Phase III hydraulic model to estimate expected annual damages, benefits, and project performance.

APPENDIX D: OTHER SOCIAL EFFECTS

47. Comment on the adequacy and comprehensiveness of the other social effects analysis.

APPENDIX E: CULTURAL RESOURCES

No questions.

APPENDIX F: ENVIRONMENTAL

48. Comment on the accuracy and comprehensiveness of the analyses used to estimate the acreage and types of impacts to wetlands.

49. Comment on the accuracy and comprehensiveness of the analyses used to determine the Farmland Conversion Impact Rating.

APPENDIX G: REAL ESTATE

No questions.

APPENDIX H: GEOTECHNICAL ANALYSIS: CREDIT TO EXISTING LEVEES

No questions

APPENDIX I: GEOTECHNICAL DESIGN AND GEOLOGY

50. Comment on the scope of the subsurface investigation and laboratory testing programs used to define the subsurface conditions and selection of design parameters and any implications these data might have on project pre-design considerations.

51. Comment on the adequacy of the information obtained from the subsurface investigation to determine the impact of groundwater at the pre-design phase.

52. Comment on the geotechnical design methodology approach used to analyze the project features along with the overall degree of conservatism employed in the seepage and slope stability analyses.

APPENDIX J: STRUCTURAL

53. Comment on the suitability and thoroughness of the technical assumptions used to recommend proposed placement of bridge and hydraulic control structures.

54. Comment on the basic investigative techniques and interpretive methodologies used in the engineering feasibility analysis.

55. Comment on the precision and comprehensiveness of the design assumptions used to develop the cost estimates and preliminary bridge layout drawings.

56. Comment on the overall degree of conservatism employed in the consideration of ice conditions and/or ice and flooding conditions within the conceptual level analyses.

57. Comment on the precision and comprehensiveness of the design assumptions and parameters used to develop the concept level design for the hydraulic structures.

APPENDIX K: CIVIL ENGINEERING

No questions.

APPENDIX L: COST

58. Comment on whether this appendix adequately describes the revised methods for estimating the costs associated with project alternatives such as with the excavation and construction of the diversion channel and the major hydraulic structures.

59. Comment on the appropriateness of the level of detail provided in the Total Project Cost Summary (TPCS).

60. Comment on the appropriateness of the assumptions for the setup of the contractors from the previous review as a single contractor to a Prime Contractor functioning as a construction management firm with subcontractors doing work according to their disciplines, as well as the appropriateness of the overall contractor overhead assumptions.

APPENDIX M: RECREATION AND AESTHETICS

No questions.

APPENDIX N: NOT USED

No questions.

APPENDIX O: PLAN FORMULATION

No questions.

APPEDDIX P: NON STRUCTURAL

No questions.

APPENDIX Q: PUBLIC INVOLVEMENT AND COORDINATION

No questions.

APPENDIX R: DEIS COMMENTS

No questions.

APPENDIX S: DEIS COMMENT RESPONSES

No questions.

FINAL OVERVIEW QUESTION

61. What is the most important concern you have with the document or its appendices that was not covered in your answers to the questions above?