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# Final Independent External Peer Review Design Review Report for the Independent Review of the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS) Gulf Intracoastal Waterway (GIWW) West Closure Complex (WCC)

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U.S. Army Corps of Engineers
Coastal Storm Damage Reduction Planning Center of Expertise
Baltimore District

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SHORT TERM ANALYSIS SERVICE (STAS)

Final Independent External Peer Review: Design Review Report

for the

Independent Review of the
Greater New Orleans
Hurricane and Storm Damage Risk Reduction System (HSDRRS)
Gulf Intracoastal Waterway (GIWW) West Closure Complex (WCC)

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## ACRONYMS

| | |
|---|---|
| A/E | Architect/Engineer |
| ACI | American Concrete Institute |
| ASCE | American Society of Civil Engineers |
| CECW-CP | Corps of Engineers Civil Works – Coastal Protection |
| cfs | cubic feet per second |
| CIL | Critical Items List |
| CPRA | Coastal Protection and Restoration Authority |
| DDR | Design Documentation Report |
| DrChecks$^{SM}$ | Design Review and Checking System |
| EC | Engineering Circular |
| ECI | Early Contractor Involvement |
| ER | Engineering Regulation |
| ERDC | Engineer Research and Development Center |
| GIWW | Gulf Intracoastal Waterway |
| HSDRRS | Hurricane and Storm Damage Risk Reduction System |
| IEPR | Independent External Peer Review |
| IPET | Interagency Performance Evaluation Task Force |
| MVN | Mississippi Valley Division, New Orleans District |
| O&M | Operations and Maintenance |
| OMB | Office of Management and Budget |
| PCX | Planning Center of Expertise |
| PDT | Project Delivery Team |
| PRQCP | Peer Review Quality Control Plan |
| SWP | Spiral-welded pipe |
| USACE | United States Army Corps of Engineers |
| WCC | West Closure Complex |
| WRDA | Water Resources Development Act |

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**Final Independent External Peer Review Report For The Design Review of the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS) Gulf Intracoastal Waterway (GIWW) West Closure Complex (WCC)**

# Executive Summary

The U.S. Army Corps of Engineers (USACE) is currently designing and constructing the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS). One of the vital components of this system is the Gulf Intracoastal Waterway (GIWW) West Closure Complex (WCC) project, a combination of navigable floodgates, a pump station, levees, floodwalls, and channels designed to provide a barrier to storm surges and sufficient pumping of interior drainage. USACE utilized the Early Contractor Involvement (ECI) method of project delivery.

Because of the uniqueness and complexity of this project, an Independent External Peer Review (IEPR) of the GIWW WCC project was conducted. Independent and objective peer review is regarded as a critical element in ensuring the reliability of scientific analyses and engineering utilized for project execution.

Battelle Memorial Institute (hereinafter Battelle), as a 501(c)(3) non-profit science and technology organization with experience in establishing and administering peer review panels, was engaged to execute and conduct the IEPR of the Greater New Orleans HSDRRS GIWW WCC. The IEPR followed the procedures described in the Department of the Army, USACE guidance *Peer Review of Decision Documents* (Engineering Circular [EC] 1105-2-410) dated August 22, 2008; *Peer Review Process* (Corps of Engineers Civil Works – Coastal Protection [CECW-CP] Memorandum) dated March 30, 2007; *Engineering and Design, Quality Management* (Engineering Regulation [ER] 1110-1-12) dated July 21, 2006; *Engineering and Design, DrChecks* (ER 1110-1-8159) dated May 10, 2001 and *Civil Works Review Policy* (EC 1165-2-209) dated January 31, 2010.

This final GIWW WCC IEPR design review report describes the IEPR process developed by Battelle and followed by Battelle's external peer review experts (also known as the Panel or panel members), including a summary of final comments from the Panel, and describes the panel members' qualifications and the selection process. This report only covers the findings of the design report; a separate report has been prepared on the construction site visits.

Battelle uses both an internal database and external resources to identify candidate panel members. From a list of potential candidates, Battelle confirmed their availability, evaluated their technical expertise, and inquired about potential conflicts of interest. The credentials of the available candidate panel members were evaluated according to the overall scope of the GIWW WCC IEPR project engineering requirements. Participation in previous USACE technical review committees and other technical review experience was also considered.

Eight panel members were selected from those who met the criteria; the panel members covered the following disciplines:

- Geotechnical engineering
- Structural engineering
- Civil engineering
- Hydraulic engineering
- Mechanical engineering
- Materials engineering
- Electrical engineering
- Operations and maintenance (O&M) engineering

On August 6, 2009, the Panel participated in an orientation briefing where they were briefed on the GIWW WCC project by the USACE Project Delivery Team (PDT). The orientation briefing included a visit to the construction site. The IEPR panel members started their review of the project design documentation on May 18, 2010, and produced 384 comments.

The IEPR Panel's comments were entered into DrChecks$^{SM}$, a Web-based software system for documenting and sharing comments on reports and design documents. The USACE PDT then provided evaluations of those comments. The IEPR panel members prepared BackCheck responses to the USACE evaluations, and those comments that the IEPR panel members believed were adequately addressed by the USACE PDT were closed. Comments that remained open were discussed during two teleconferences held between Battelle, the IEPR Panel, and the USACE PDT, with USACE Planning Center of Expertise (PCX) staff in attendance. The teleconferences were held on September 15, 2010 and December 3, 2010. Due to time limitations, not all open comments were resolved during the two teleconferences; therefore, a final face-to-face meeting was conducted at the USACE District office in New Orleans, Louisiana, on February 24, 2011, to discuss remaining open comments. Attending the meeting were USACE PCX staff, USACE PDT, Battelle staff, and the appropriate IEPR panel member.

At the conclusion of the face-to-face meeting, the USACE PDT was tasked with responding to the Panel's comments in DrChecks. After the USACE PDT completed its responses, the panel members provided BackCheck responses in DrChecks, resulting in all comments being closed in DrChecks by July 19, 2011.

# 1 INTRODUCTION

## 1.1 Program Background

The U.S. Army Corps of Engineers (USACE) is currently designing and constructing the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS). One of the vital components of this system is the Gulf Intracoastal Waterway (GIWW) West Closure Complex (WCC) project, a combination of navigable floodgates, a pump station, levees, floodwalls, and channels designed to provide a barrier to storm surges and sufficient pumping of interior drainage. USACE utilized the Early Contractor Involvement (ECI) method of project delivery.

Because of the uniqueness and complexity of this project, an Independent External Peer Review (IEPR) of the GIWW WCC project was conducted. Independent, objective peer review is regarded as a critical element in ensuring the reliability of scientific analyses and engineering.

Battelle Memorial Institute (hereinafter Battelle), as a 501(c)(3) non-profit science and technology organization with experience in establishing and administering peer review panels, was engaged to execute and conduct the IEPR of the Greater New Orleans HSDRRS GIWW WCC. The IEPR followed the procedures described in the Department of the Army, USACE guidance *Peer Review of Decision Documents* (Engineering Circular [EC] 1105-2-410) dated August 22, 2008; *Peer Review Process* (Corps of Engineers Civil Works – Coastal Protection [CECW-CP] Memorandum) dated March 30, 2007; *Engineering and Design, Quality Management* (Engineering Regulation [ER] 1110-1-12) dated July 21, 2006; *Engineering and Design, DrChecks* (ER 1110-1-8159) dated May 10, 2001 and *Civil Works Review Policy* (EC 1165-2-209) dated January 31, 2010.

This final GIWW WCC IEPR design review report describes the IEPR process developed by Battelle and followed by Battelle's external peer review experts (also known as the Panel or panel members), including a summary of final comments from the Panel, and describes the panel members' qualifications and the selection process. This report only covers the findings of the design report; a separate report has been prepared on the construction site visits.

## 1.2 Project Description

The GIWW WCC project is located on the west bank of the Mississippi River near New Orleans, Louisiana. The GIWW WCC project is located west of the Algiers and Harvey canals and is intended to provide a barrier to storm surges and sufficient pumping of interior drainage. The GIWW WCC project consists of the following five major features:

- 19,140 cubic-foot-per-second (cfs) drainage pumping station containing large mixed-flow, vertical-type pumps;
- 225-foot navigable sector gate;
- Sluice gate;
- Flood wall to protect an area identified as the 404(c) area; and,
- Closure wall to connect the floodwall and the 225-foot sector gate.

This IEPR reviewed and assessed design criteria within the design documentation reports (DDRs) for each of the five major features of the GIWW WCC.

### 1.3 Purpose of the IEPR

The purpose of an IEPR is to strengthen the quality and credibility of USACE's decisions in support of its Civil Works program in compliance with the Water Resources Development Act (WRDA) Section 2035 and Water Resources Policies and Authorities, *Civil Works Review Policy* (EC 1165-2-209) dated January 31, 2010. To help ensure that USACE documents are supported by the best scientific and technical information, a peer review process has been implemented by USACE that utilizes an IEPR to complement the agency technical review, as described in the USACE guidance titled *Peer Review of Decision Documents* (EC 1105-2-410) dated August 22, 2008, and the CECW-CP Memorandum titled *Peer Review Process* dated March 30, 2007. In this case, the IEPR of the GIWW WCC was conducted and managed using contract support from an independent 501(c)(3) organization, Battelle, to ensure independent objectivity, along with a high degree of flexibility and responsiveness, which was essential for USACE to meet deadlines.

## 2 IEPR PROCESS

This section describes the approach for selecting IEPR panel members, and the planning and processes for conducting the IEPR. The IEPR followed the process described in the Peer Review Quality Control Plan (PRQCP) that Battelle developed specifically for this project. It was conducted following procedures described in USACE's guidance cited above (see Section 1.1) and in accordance with the Office of Management and Budget's (OMB's) *Final Information Quality Bulletin for Peer Review*, released December 16, 2004. In addition, the process followed supplemental guidance on the evaluation of conflicts of interest from the National Academies' *Policy on Committee Composition and Balance and Conflicts of Interest for Committees Used in the Development of Reports*, dated May 12, 2003.

### 2.1 Planning and Schedule

In June 2009, Battelle was provided with a notice to proceed with the IEPR of the GIWW WCC project. After an orientation briefing in August 2009, the IEPR was placed on-hold while the USACE Project Delivery Team (PDT) conducted a design summit to re-evaluate the design of the GIWW WCC project. The Panel was not engaged during the duration of time the re-evaluation was conducted by the PDT. The IEPR of the GIWW WCC project resumed in May 2010 with review of the Pump Station DDR and supporting materials. The USACE PDT also briefed the Panel via teleconference on May 25, 2010, to update them on the overall project status. All IEPR reviewer comments were closed by July 19, 2011.

Table 1 provides the GIWW WCC IEPR schedule.

**Table 1. GIWW WCC IEPR Schedule**

| Task | Action | Completed By Date |
|---|---|---|
| | Notice to Proceed | 30-Jun-2009 |
| 1 | Submit PRQCP | 04-Aug-2009 |
| 2 | Independent Peer Review Panel:<br><br>Submit list of Final IEPR Panel Members:<br>IEPR Panel Members under Contract | <br><br>09-Jul-2009<br>14-Jul-2009 |
| 3 | Submit Peer Review Critical Items List (CIL) | 21-Aug-2009 |
| 4 | Attend Orientation Briefing<br><br>Project Status Update | 06-Aug-2009<br><br>25-May-2010 |
| 5 | Peer Review of Project Design:<br><br>Receive Pump Station DDR Documents<br>Pump Station DDR Comments submitted to DrChecks<br>Pump Station DDR Comments Closed<br><br>Receive 404c Wall DDR Documents<br>404c Wall DDR Comments submitted to DrChecks<br>404c Wall DDR Comments Closed<br><br>Receive Large Sector Gate DDR Documents<br>Large Sector Gate DDR Comments submitted to DrChecks<br>Large Sector Gate DDR Comments Closed<br><br>Receive Closure Wall DDR Documents<br>Closure Wall DDR Comments submitted to DrChecks<br>Closure Wall DDR Comments Closed<br><br>Receive Sluice Gate DDR Documents<br>Sluice Gate DDR Comments submitted to DrChecks<br>Sluice Gate DDR Comments Closed | <br><br>18-May-2010<br>01-Jul-2010<br>19-Jul-2011<br><br>20-May-10<br>18-Aug-2010<br>28-Apr-2011<br><br>01-Jun-2010<br>08-Jul-2010<br>19-Jul-2011<br><br>14-Jun-2010<br>23-Jul-2010<br>19-Jul-2011<br><br>24-Jun-2010<br>09-Sept-2010<br>06-Apr-2011 |
| 6 | Peer Review of Construction Activities:<br><br>Site Visit 1<br>Site Visit 1 Report<br>Site Visit 2<br>Site Visit 2 Report<br>Site Visit 3<br>Site Visit 3 Report | <br><br>28 Jul-10<br>25 Aug-10<br>11 Jan-11<br>03-Feb-11<br>23-Sept-11<br>18-Nov-11 |
| 7 | Prepare Final Reports:<br><br>Submit Draft Final Design Review Report<br>Submit Final Design Review Report<br>Submit Draft Final Construction Site Visit Review Report<br>Submit Final Construction Site Visit Review Report | <br><br>15-Sept-11<br>16-Dect-11<br>19-Dec-11<br>22-Dec-11(anticipated) |

## 2.2 Peer Review Quality Control Plan

Battelle developed a PRQCP for the IEPR of the GIWW WCC to provide a detailed process for conducting the IEPR and establish quality control protocols for the review process. The primary focus of the IEPR process is to conduct an independent review based on specific engineering disciplines to ensure that the design is technically sound. The PRQCP incorporated guidance included in the USACE *Engineering and Design Quality Management Plan* (ER 1110-1-12), Battelle's internal quality and management programs, and the Statement of Work for the GIWW WCC IEPR project.

## 2.3 Identification and Selection of IEPR Panel Members

Battelle uses both an internal database and external resources to identify candidate panel members. From a list of potential candidates, Battelle confirmed their availability, evaluated their technical expertise, and inquired about potential conflicts of interest. The credentials of the available candidate panel members were evaluated according to the overall scope of the GIWW WCC project engineering requirements. Participation in previous USACE technical review committees and other technical review experience was also considered.

The candidate panel members were screened for the following *potential* exclusion criteria or conflicts of interest:

- Financial or litigation association with USACE, "The State" (defined as the State of Louisiana and Local governing entities including Southeast Louisiana Flood Protection Authority), the Design Architect/Engineer (A/E), their engineering teams, subcontractors, or construction contractors.
- Current USACE, Federal, or state government employee.
- Current personal or firm involvement as a cost-share partner on USACE projects. If yes, provide description.
- You or your firm made a publicly documented statement advocating for or against any HSDRRS project.
- Paid or unpaid participation in litigation related to the work of the USACE.
- Current or future interests in the subject project or future benefits from the project.
- Current personal or firm involvement with other USACE projects. If yes, provide title/description, dates, and location (USACE district, division, Headquarters, Engineer Research and Development Center [ERDC], etc.), and position/role.
- Previous employment by USACE as a direct employee or contractor (either as an individual or through your firm) within the last 10 years. If yes, provide title/description, dates employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.
- A significant portion of personal or firm revenues within the last 3 years came from USACE contracts.

- Other USACE affiliation [Scientist employed by the USACE (except as described in National Academy of Science criteria, see ECs 1105-2-4 section 9b)][a].
- Personal relationships with USACE staff in Mississippi Valley Division Headquarters, Task Force Hope, New Orleans District (Protection Restoration Office), Hurricane Protection Office, or officials from the State of Louisiana and Local governing entities including Southeast Louisiana Flood Protection Authority.
- Participation in the Interagency Performance Evaluation Task Force (IPET), American Society of Civil Engineers (ASCE) External Review of IPET, the Louisiana Coastal Protection and Restoration Study, and/or National Research Council Committee on New Orleans Regional Hurricane Protection Projects.

The IEPR candidates who best fit the criteria for the required expertise and did not have any actual or perceived conflicts of interest were selected. Based on these considerations, eight panel members were selected from the list of candidates as the final IEPR Panel (see Section 3 for biographical information on the selected panel members). The eight selected panel members were either independent engineering consultants or affiliated with professional engineering firms.

Corresponding to the technical content of the GIWW WCC Project statement of work, the areas of technical expertise of the eight[b] selected panel members consisted of the following:

- Geotechnical engineering
- Structural engineering
- Civil engineering
- Hydraulic engineering
- Mechanical engineering
- Materials engineering
- Electrical engineering
- Operations & maintenance (O&M) engineering.

Battelle established subcontracts with the selected panel members after confirming the absence of conflicts of interest through a signed conflict of interest form.

[a] Note: Battelle will be evaluating whether scientists in universities and consulting firms that are receiving USACE funding have sufficient independence from USACE to be appropriate peer reviewers. See OMB memo M-05-03, 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."

[b] Originally, there were eight panel members. The original civil engineering panel member left the project, and the O&M engineering panel member had sufficient experience to fulfill the civil engineering role in addition to his own.

## 2.4 Orientation Briefing

On August 6, 2009, Battelle staff and the IEPR Panel gathered at USACE's New Orleans District in New Orleans, Louisiana, for an orientation briefing on the GIWW WCC Project. During the briefing, the USACE PDT briefed Battelle and the IEPR Panel on the entire Greater New Orleans HSDRRS program and provided an overview of the GIWW WCC Project. The overview described the need for the project, the scope of the project, the concerns and desired goals of various stakeholders, the design criteria, and the general approach to the project's design and construction.

Following the briefing, members of the USACE PDT, USACE Planning Center of Expertise (PCX) staff, Battelle staff, IEPR Panel, and local representatives boarded a boat at the USACE district office and traveled to the GIWW WCC project site to view the site's existing conditions. Throughout the trip, the USACE PDT members identified various project features and answered questions posed by the IEPR panel members.

On May 25, 2010, the USACE PDT provided a project status update to the IEPR Panel. During that update, the Panel learned that the design documents for the GIWW WCC project were nearly complete and that significant construction had taken place.

## 2.5 Critical Items List

The Critical Items List (CIL) is a product of an analysis by the IEPR Panel that is intended to provide a more comprehensive assessment of all project components whose specific failure and related failure modes could result in serious injury or loss of life and/or the loss of one or more mission objectives. The CIL also helps to reinforce the general charge to the IEPR Panel by stressing a focus on the redundancy, resilience, and robustness of the project features assessed during the IEPR. The panel members prepared individual CILs shortly after attending the orientation briefing, and a combined project CIL was used throughout the IEPR to focus the panel on specific critical project features during their review of design documents and construction activities rather than on non-critical detail contained in the design documents. A sample critical item for the GIWW WCC project is shown in Figure 1.

### 2.5.1 Document Review

The GIWW IEPR design review consisted of reviewing the DDRs for the major project features of the GIWW WCC project consisting of the:

- Pump Station – 100% Submittal DDR
- Large Sector Gate – Preliminary 95% Submittal DDR
- Sluice Gate – 95% Submittal DDR
- 404c Wall– Draft 100% DDR
- Closure Wall – 100% DDR

| Civil 003: GIWW WCC – Pumping Station | | | |
|---|---|---|---|
| **1** | **Component Name:** | Pump station | |
| **2** | **Component Function** | Pumps water from protected side of levee and flood walls during storm events when the sector gates are closed. | |
| **3** | **Failure Mode** | Intake restricted by accumulation of large floating debris along with trash on trash racks. | Intake damaged by barge, other vessels, or large floating debris. |
| **4** | **Cause of Failure** | Restriction of inflow to vertical pumps reduces pump station efficiency. | Flood waters on protected side rise significantly and may overtop interior levee and walls. |
| | | Barge is lodged longitudinally in front of the pump station intake due to failure of the concrete dolphins on pump intake side. | Partial blockage of barge up against concrete dolphins increases velocities and ultimately increases forces on the dolphins. Can result in complete dolphin failure. |
| **5** | **Effects of Failure** | Partial or full collapse of pump intake. | Localized flooding on protected side. |
| | | Improper pumping operations. | |
| **6** | **Criticality of Effects** | Partial or full collapse of pump intake. (Severe) | |
| | | Damage to pumps due to debris passing through the damaged trash racks. (Moderate) | |
| | | Loss of flood protection. (Severe) | |
| **7** | **What are the safeguards against significant failures:**<br>**a) Redundancy**<br>**b) Resilience**<br>**c) Robustness** | Proper design loads and methodology related to dolphins used to fender barges and large floating debris to prevent direct blocking of inflow. | |
| | | Proper design loads and methodology. Proper use of load cases and safety factors. | |
| | | Increase dolphin size. | |

**Figure 1. Example of a Critical Item Identified by the Civil Engineering IEPR Panel Member**

The following reference documents were provided by the USACE as support/background documents for the IEPR Panel to consult as needed:

- Design A/E's Scope of Work
- General Charge Guidance
- Plans and specifications for each major feature
- HSDRRS Quality Management Plan, 17 April 2009

In addition, the HSDRRS Design Guidelines dated October 2007, with revisions dated 12 June 2008, were available to the Panel.

To maintain independence and control consistent with USACE IEPR guidance, the IEPR panel members did not have direct or unmonitored e-mail or phone contact with the USACE PDT. All interactions between the IEPR panel members and USACE PDT occurred in DrChecks, during the orientation briefing, during the final face-to-face meeting, or via teleconference and were always facilitated by Battelle and the USACE PCX representatives.

In total, the seven IEPR panel members produced 384 individual comments for the GIWW WCC design review. Of these 384 comments, the IEPR panel members identified 128 of the comments as critical. For this IEPR, critical comments are defined as issues which could lead to a critical failure of the component, structure, or mission. Figure 2 shows an example of a critical comment from the IEPR panel members. The names of the IEPR panel member and USACE PDT member providing the comment and response have been removed in this example.

| Id | Discipline | Section/Figure | Page Number | Line Number |
|---|---|---|---|---|
| 3342176 | Operations | n/a' | 61 | n/a |

States, "Basic Trash Rack Design Criteria – Design Differential Head: 5 feet of water." Previous design documents set this at 0.5 feet of water which seems more appropriate considering the pumps have a potential cavitation risk below a stage of 0.0. We encounter this problem frequently in Florida when the trash builds up on the screens.

Submitted By: Submitted On: 18-Jun-10

| | |
|---|---|
| **1-0** | Evaluation **Concurred**<br>The 5 feet of water is a structural parameter and not a control set point. Operation will be that the screen will run continuously when the pump is in operation during storm events and otherwise will work on an internal timer during exercise of the station. The DDR will be updated to clarify this.<br><br>Submitted By: Submitted On: 30-Jul-10 |
| **1-1** | Backcheck Recommendation **Close Comment**<br>Closed without comment.<br><br>Submitted By: Submitted On: 26-Aug-10 |
| | Current Comment Status: **Comment Closed** |

**Figure 2. Example of a Critical Comment from the Review**

### 2.5.2 Comment Resolution

The IEPR Panel's comments were entered into DrChecks[SM], a Web-based software system for documenting and sharing comments on reports and design documents. The USACE PDT then provided evaluations of those comments. The IEPR panel members prepared BackCheck responses to the USACE evaluations, and those comments that the IEPR panel members

considered adequately addressed by the USACE PDT were closed. Comments that remained open were discussed during two teleconferences held between Battelle, the IEPR Panel, and the USACE PDT, with USACE PCX staff in attendance. The teleconferences were held on September 15, 2010 and December 3, 2010. Due to scheduling limitations on the days of the teleconferences, not all open comments were resolved during the two teleconferences; therefore, a final face-to-face meeting was conducted at the USACE District office in New Orleans, Louisiana, on February 24, 2011, to discuss remaining open comments. Attending the meeting were USACE PCX staff, USACE PDT, Battelle staff, and the appropriate IEPR panel member.

Overall, the face-to-face meeting was successful in clarifying the open issues. At the conclusion of the meeting, the USACE PDT was tasked with responding to the IEPR panel member comments in DrChecks. After the USACE PDT completed its responses to panel member comments, the IEPR provided BackCheck responses in DrChecks, resulting in all comments being closed in DrChecks by July 19, 2011.

### 2.6 Review of Construction Activities

As part of the overall GIWW WCC IEPR, the IEPR panel members were tasked with making site visits (two per reviewer) to review construction activities. Two of the three construction site visits were concurrently executed with the review of the project design documents. This provided an excellent opportunity for the IEPR panel members to better assess the information in the design documentation. The IEPR construction site visits will be documented in a separate final report.

### 2.7 IEPR Final Report

After concluding the review, Battelle prepared this final design review report on the overall IEPR process and the IEPR panel members' findings. The report was reviewed by each IEPR panel member and by Battelle technical and editorial experts as an integral part of the process prior to being submitted to the USACE.

## 3 IEPR PANEL MEMBER SELECTION

Potential peer review candidates were identified through Battelle's IEPR database of experts, trade organizations, engineering societies, targeted recruitment (e.g., terms focusing on technical area and geographic region), recruitment at universities for key expertise, or other recruitment processes.

All IEPR panel members met or exceeded the following minimum requirements:

- Registered professional engineer (or equivalent in home country)
- Engineering degree with masters preferred
- 20 years of experience with responsibilities for related project engineering work

Panel members in each discipline also were required to have specific technical experience in the areas summarized in Table 2.

**Table 2. Required Technical Experience for IEPR Panel Members**

| Discipline | Required Experience |
|---|---|
| Geotechnical Engineer | • Very soft Louisiana-type clay soil foundations<br>• Large diameter pile design<br>• Axial and lateral load testing for piles<br>• T-wall and L-wall design<br>• Subsurface investigations in very soft soil<br>• Seepage design<br>• Wave impact/armoring<br>• Slope stability analyses for very soft soils<br>• Quality control testing<br>• Spencer's Method experience<br>• Knowledge of the output files of currently used and available computer analysis programs |
| Structural Engineer | • Sector gates and/or lift gates subject to high wind and wave loading<br>• T-wall and L-wall floodwall design |
| Hydraulic Engineer | • Hurricane surge and wave generation<br>• Navigational hydraulics<br>• Sizing large pump stations, including experience with pump suction/sump basins, head conditions, and inflow/outflow channel designs |
| Mechanical Engineer | • Gate machinery<br>• Hydraulic systems and generators<br>• Pump stations that have a minimum 2,000 cfs total capacity and minimum 500 cfs per individual pump |
| Materials Engineer | • Hot weather concreting operations<br>• Mass concrete placement<br>• Lightweight concrete<br>• Site cast concrete<br>• Pumped concrete and tremie concrete<br>• Quality control testing experience |
| Electrical Engineer | • Generated power<br>• Controls, instrumentation, and Supervisory Control and Data Acquisition |
| Civil Engineer | • Designs utilizing very soft soils and in design of levees<br>• Large civil work hydraulic structures<br>• Erosion control<br>• Timber guide and protection walls |
| O&M Engineer | • O&M of major civil work hydraulic structures<br>• Navigation gates<br>• Pump stations that have a minimum 2,000-cfs total capacity and minimum 500 cfs per individual pump |

Battelle screened candidate IEPR panel members for availability, technical background, and conflicts of interest, and prepared a draft list of peer review candidates for coordination with the USACE. Battelle selected the final IEPR panel members (Table 3) based on their specific experience in the areas of expertise specified in the scope of work (Table 4).

**Table 3. Final IEPR Panel Members**

| Discipline/Name | Affiliation | Location | Education | P.E. | Years of Experience |
|---|---|---|---|---|---|
| **Geotechnical Engineer** | | | | | |
| David E. Lourie | Lourie Consultants | Metairie, LA | BSCE, MSCE | Yes | 30 |
| **Structural Engineer** | | | | | |
| Bill Miles | Bergman Associates | Rochester, NY | BSCE | Yes | 36+ |
| **Hydraulic Engineer** | | | | | |
| Michael Ports | Independent Consultant | Jacksonville, FL | BSCE, MS (Water Resources) | Yes | 39 |
| **Mechanical Engineer** | | | | | |
| Paul Carson | Currents Consulting | Kirkland, WA | BSCE, MSME | Yes | 33+ |
| **Materials Engineer** | | | | | |
| Ebow Coleman | C3S, Inc. | Houston, TX | BS, MS, Ph. D. (Cement and Concrete Technology) | Yes | 28 |
| **Electrical Engineer** | | | | | |
| Robbie Cameruca | Burgess & Niple | Columbus, OH | BSEE | Yes | 24 |
| **O&M Engineer, Civil Engineer*** | | | | | |
| Alan Hall* | Independent Consultant | Melbourne, FL | BS (Professional Management) | Yes | 36 |
| **Civil Engineer** | | | | | |
| Bill Schaefer* | Dominion Engineering Group, Inc. | Jacksonville, FL | BSCE | Yes | 26 |

*Alan Hall assumed the Civil Engineering role from Bill Schaefer midway through the review.

**Table 4. Specific Experience of IEPR Panel Members Requested in Scope of Work**

| Expertise | Total | Lourie | Miles | Ports | Carson | Coleman | Cameruca | Schaefer | Hall |
|---|---|---|---|---|---|---|---|---|---|
| **Geotechnical Engineer – Lourie** | | | | | | | | | |
| Very soft Louisiana-type soil foundations | 2 | X | | | | | | | X |
| Large diameter pile design | 1 | X | | | | | | | |
| Axial and lateral load testing for piles | 1 | X | | | | | | | |
| T-wall and L-wall design | 1 | X | | | | | | | |
| Subsurface investigations in very soft soil | 1 | X | | | | | | | |
| Seepage design | 2 | X | | | | | | | X |
| Wave impact/armoring | 2 | X | | | | | | | X |
| Slope stability analyses for very soft soils | 2 | X | | | | | | | X |
| Quality control testing | 1 | X | | | | | | | |
| Spencer's Method experience and knowledge of the output files of currently used and available computer analysis programs | 1 | X | | | | | | | |
| **Structural Engineer – Miles** | | | | | | | | | |
| Sector and/or lift gates subject to high wind and wave loading | 2 | | X | | | | | | X |
| T-wall & L-wall floodwall design | 1 | | X | | | | | | |
| **Hydraulic Engineer – Ports** | | | | | | | | | |
| Hurricane surge and wave generation | 2 | | | X | | | | | X |
| Navigational hydraulics | 3 | | | X | | | | X | X |
| Sizing large pump stations to include experience with pump suction/sump basins, head conditions, and inflow/outflow channel designs | 1 | | | X | | | | | |
| **Mechanical Engineer – Carson** | | | | | | | | | |
| Gate machinery | 1 | | | | X | | | | |
| Hydraulic systems | 1 | | | | X | | | | |
| Generators | 1 | | | | X | | | | |
| Pump stations that have a minimum 2,000 cfs total capacity and minimum 500 cfs per individual pump | 1 | | | | X | | | | |

**Table 4 Specific Experience of IEPR Panel Members Requested in Scope of Work (cont).**

| Expertise | Total | Lourie | Miles | Ports | Carson | Coleman | Cameruca | Schaefer | Hall |
|---|---|---|---|---|---|---|---|---|---|
| **Materials Engineer – Coleman** | | | | | | | | | |
| Hot weather concreting operations | 3 | X | X | | | X | | | |
| Mass concrete placement | 2 | | X | | | X | | | |
| Lightweight concrete | 1 | | | | | X | | | |
| Sitecast concrete | 2 | | X | | | X | | | |
| Pumped concrete | 3 | X | X | | | X | | | |
| Tremie concrete | 3 | X | X | | | X | | | |
| Quality control testing | 2 | X | | | | X | | | |
| **Electrical Engineer – Cameruca** | | | | | | | | | |
| Power | 1 | | | | | | X | | |
| Controls | 2 | | | | X | | X | | |
| Instrumentation | 1 | | | | | | X | | |
| Supervisory Control and Data Acquisition | 1 | | | | | | X | | |
| **Civil Engineer – Hall (replaced Schaefer midway through the review)** | | | | | | | | | |
| Designs utilizing very soft soils | 3 | X | | | | | | X | X |
| Design of levees | 5 | X | X | X | | | | X | X |
| Large civil work hydraulic structures | 4 | | X | | X | | | X | X |
| Erosion control | 3 | | | X | | | | X | X |
| Timber guide and protection walls | 1 | | | | | | | X | |
| **O&M Engineer – Hall** | | | | | | | | | |
| O&M of major civil works hydraulic structures including navigation gates and pump stations that have a minimum 2,000 cfs total capacity and minimum 500 cfs per individual pump | 1 | | | | | | | | X |

The credentials of the eight panel members selected for the IEPR and their qualifications in relation to the technical evaluation criteria are summarized below

**David E. Lourie** is a consulting engineer with expertise in South Louisiana soil conditions, local area geology, and geotechnical design and construction. In his 30-year career, he has performed complex geotechnical studies for the petrochemical industry, airports, ports, State and Federal agencies, and others in the region. Before forming Lourie Consultants in 1992, he spent nine years directing the technical and financial operations of Fugro-McClelland (Southeast), Inc. and McClelland Engineers in Louisiana. Before that, he worked as an onshore and offshore geotechnical engineer for McClelland Engineers in Houston, Texas, and as a soil and materials engineer for STS Consultants in Chicago, Illinois. He has served as a liaison to the Peer Review Committee of ASFE/The Geoprofessional Business Association, has served as a Peer Review captain, and is an ASFE national past president. Mr. Lourie has been an adjunct associate professor at Tulane University, a visiting professor at McNeese State University, and a guest lecturer at Louisiana State University and the University of New Orleans. He is an active member of numerous technical and professional societies, including ASFE/The Geoprofessional Business Association, Louisiana Engineering Society, National Society of Professional Engineers, ASCE, Geo-Institute, ASCE Geotechnical Activities Group of New Orleans, and American Council of Engineering Companies/Louisiana, and American Council of Engineering Companies. In 2010, the Academy of Geo-Professionals, an ASCE affiliate, elected Mr. Lourie a Diplomate, Geotechnical Engineering.

**Bill Miles** has 36 years of experience in consulting engineering, most of which has been involved with the structural design and project management for waterways and flood control projects around the United States. Mr. Miles is the Business Director for Civil Works at Bergmann Associates and functions as the navigation structures technical leader. He has worked primarily on a wide variety of lock and dam projects on the inland waterways of the Mississippi and Ohio River Systems for USACE and for state canal agencies throughout the Eastern United States. His expertise includes steel, timber, and concrete new designs and rehabilitations for locks, fixed and gated dams, levees, gates, closure structures, river and flood walls, pumping stations, large culverts, and cofferdams. He has helped to pioneer the use of large precast concrete elements for civil works projects and for the design and construction of projects "in-the-wet" (without large cofferdams). Mr. Miles has been very involved with the International Concrete Repair Institute, the World Association for Waterborne Transport Infrastructure, the Society of American Military Engineers, and ASCE and is a frequent presenter of projects and innovative designs for national and regional conferences.

**Michael A. Ports** has more than 40 years of planning, analysis, design, and construction experience in a broad spectrum of water resources engineering applications, including surface water hydrology and hydraulics, navigation engineering, master planning, soil and water conservation, urban drainage and flood control, river training works, stream channel restoration, erosion and sediment control, environmental impact assessment, sediment transport modeling, bridge scour analysis, and environmental regulatory compliance. As a principal engineer, Mr. Ports has overseen numerous water resources projects. For example, for the Kansas City Downtown Airport, Mr. Ports performed the critical review of the hydraulic design for proposed modifications to the Missouri River levee to accommodate safety-required runway lengthening. Previously, he also performed a critical evaluation of the hydrologic and hydraulic engineering aspects of the design, operation, and maintenance of the Upper Mississippi River Navigation System for the U.S. Department of Justice. The system consists of 29 locks and dams on the

mainstream of the Mississippi River extending from St. Paul, Minnesota, to St. Louis, Missouri, a total distance of 857.6 miles. The evaluation included the critical review of the navigation system regulation and operation, effects of wing dams, erosion on river levees, seepage under and through river levees, maintenance dredging operations, and the need for river levees.

**Paul Carson** is a registered professional engineer with 33 years of mechanical engineering experience, including 30 years in design, planning, estimating, and construction management of hydroelectric and water resource projects. His experience includes design and specification of mechanical and control systems, shop drawing review, field inspections, contract administration, turbine-generator performance testing, and operational testing of mechanical systems. He has prepared final design plans, specifications, and cost estimates for a wide range of hydraulic machinery required for hydroelectric plants, navigation projects, fish passage, and water conveyance systems. For each of these assignments, Mr. Carson was directly involved in the sizing of major project features and equipment and in the development of operating plans and control schemes.

**Ebow Coleman** is a cement and concrete technology engineer who specializes in construction materials, forensic study of concrete components and structures, concrete repair and restoration, and research and development. Dr. Coleman's experience has included providing several consulting services to the City of Houston, Harris County, Engineering Department, and the Port of Houston; providing management oversight for field and laboratory technicians in concrete and soil projects; directing several repair/rehabilitation projects that involve public buildings, industrial facilities, and residential units; and performing condition surveys on highways, dams, and marine structures. Dr. Coleman has carried out several evaluations to determine the cause(s) of a wide variety of concrete distresses in regular buildings and large infrastructural facilities.

**Robbie Cameruca** is an professional engineer with 26 years of experience and expertise in electrical power distribution systems, instrumentation and control systems, interior and exterior lighting design, ancillary systems (telecommunications, Supervisory Control and Data Acquisition, transient voltage surge suppressor power), elevator modernization (she completed design for elevator modernization for 31 systems in compliance with American Society of Mechanical Engineers A17.1 and local building codes), energy conservation analysis and design, uninterruptible power supplies, power factor correction and cogeneration. Ms. Cameruca was directly involved with over 150 buildings and facilities analysis, reports, and implementation designs that were completed for the Federal National Energy Conservation Policy Act Title III Schools and Hospitals Grant Program. She has developed scope of work for design teams (mechanical/electrical/architectural) and developed/coordinated design production and construction schedules with clients and engineering staff. Ms. Cameruca has completed a variety of design commissioning and design review projects in which she participated as an independent third party reviewer reporting to the owner with feedback to the design team. Ms. Cameruca has also assisted owners with capital planning through the execution of facilities condition assessments. Ms. Cameruca is Past President of the American Council of Engineering Companies – Ohio.

**Alan Hall** has over 36 years of experience in the fields of water resource, environmental, and civil engineering. He is currently an engineering consultant serving both public and private

clients and has managed more than $30 million in professional services contracts over the past 5 years. During his 25+ year public career, he served as the Deputy Director of Operations and Maintenance for the South Florida Water Management District. His responsibilities included leadership and control of the water management operations and project maintenance functions for a 2,000-mile water control and treatment system that provided flood control, water supply, and environmental enhancement for central and south Florida. This effort included navigation lock gate maintenance of the locks associated with the S-65, S-65A, S-65B, S-65C, S-65D, and S-65E structures on the C-38 Canal (Kissimmee River). The S-65E structure has a design discharge in excess of 15,000 cfs. Mr. Hall also possesses professional credentials in the fields of professional and engineering management.

**Bill Schaefer*** has over 26 years of experience managing and directing water resources management, ecosystem restoration, site planning, site engineering, environmental engineering, and preparation of plans and specifications for land development and community development projects. His experience includes environmental engineering for everglades restoration and complex stormwater and groundwater modeling. His experience as a project manager and regional manager brings insight garnered from his personal completion of over 50 complex water resource projects, as well as countless permits with USACE, St. Johns River Water Management District, Florida Department of Environmental Protection, and Environmental Protection Agency. Mr. Schaefer is also a state licensed Building Contractor and has knowledge of current construction techniques and methods. This knowledge complements his engineering construction management experience and thoroughness in the field. He was employed from 1980 to 1987 in the Design Branch of the USACE Jacksonville office. In that capacity, he managed the design efforts of large complex water resource projects focused on flood control and flood protection.

*Alan Hall assumed the Civil Engineering role from Bill Schaefer midway through the review.

# 4 RESULTS – SUMMARY OF REVIEW

The IEPR panel members followed the processes described in Sections 2.4 and 2.5 to conduct their review, participate in IEPR teleconferences, and address comments in DrChecks. These processes were in accordance with the PRQCP and the USACE guidance documents cited in Section 1.1. The following sections summarize the review approach undertaken by the Panel (Section 4.1), the IEPR Panel's comments that were entered into DrChecks (Section 4.2), and the important issues identified by the Panel from their overall review (Section 4.3).

## 4.1 Review Approach

This section describes the review approach undertaken by the IEPR panel members to manage their reviews and document their comments in DrChecks prior to USACE's evaluation of the comments.

### 4.1.1 General Review Approach

Generally, each IEPR panel member familiarized themselves with the features of the project and the respective design. This initial familiarization was accomplished during the orientation briefing, which included a project description and boat tour of the construction site.

After becoming familiar with the project, the IEPR panel members created a CIL to focus their review efforts on project components with potential issues such as cut-off walls, construction materials, and design and operation of mechanical and electrical systems. For each critical item identified, failure modes and causes were assessed as well as the cascading criticality of failure. This assessment provided the basis for the review of the GIWW WCC project design documents. If a concern was identified in the project design documents, the panel members provided a comment, which was then entered into DrChecks. Most disciplines used the HSDRRS Design Guidelines (dated October 2007, with revisions dated 12 June 2008) and all used their respective expertise in engineering practice and their experience as a guide for the review of the project design documents.

The IEPR panel members were encouraged to work both independently and in groups according to their assigned expertise, and to contribute to the reviews being conducted by the other disciplines, as appropriate and based upon their experience (provided in Table 4). In general, each of the panel members chose to work independently when reviewing the GIWW WCC feature design documents, although there were occasional collaborative discussions between panel members.

### 4.1.2 Discipline-Specific Review Approaches

In addition to the general approach, each IEPR panel member also employed specific approaches for his or her review of the GIWW WCC project documentation. Those specific approaches are described in the following paragraphs.

#### Geotechnical Engineering Review Approach

The geotechnical engineer used the CIL to identify geotechnical issues during the review of each project feature DDR and its supporting documentation. The documentation was studied to understand the purpose of the feature, the expected geotechnical design and construction challenges, and the designer's approach to performing the various analyses. The geotechnical engineer referred to the HSDRRS Design Guidelines (dated October 2007, with revisions dated 12 June 2008) and drew on his own knowledge and experience when reviewing the project documentations. During the review process, the geotechnical engineer focused on making an independent assessment of the:

- Adequacy, applicability, and documentation of the analytical effort;
- Appropriateness and reasonableness of the soil and groundwater parameters selected for use in the analyses and the reasonableness of the results;
- Incorporation of the results into the design;
- General constructability of the design; and,
- Anticipated performance of the feature including its overall structure during its design life.

### Structural Engineering Review Approach

The structural engineer's review of the DDRs focused on the design assumptions, criteria, loadings, and analysis methods for completeness and applicability with respect to project goals. The design was reviewed for constructability, cost effectiveness, temporary flood protection, and project schedule. The use of the ECI and the lessons learned from that contracting process were also considered in the review.

The HSDRRS Design Guidelines (dated October 2007, with revisions dated 12 June 2008) with respect to the structural design were used to assist in the review of the DDRs for each feature. The structural engineer also considered the fact that the project had a sector gate much larger than any previously fabricated and installed in the United States; and a pump station of unique size and pump type. Other comments outside of the structural discipline, especially those made by the civil, materials, and geotechnical panel members, were considered for additional comments or coordination. Structural comments were explained to other panel members to assist in their reviews as well.

### Hydraulic Engineering Review Approach

The hydraulic engineer reviewed the project documents for completeness and applicability, including the project background, requirements, and design criteria. The HSDRRS Design Guidelines (dated October 2007, with revisions dated 12 June 2008) with respect to the reviewer's background and experience and the USACE engineering regulations, manuals, guidelines, and technical letters for flood and hurricane protection were used to assist in the review of the DDRs for each feature. The review included application of the specific requirements of Greater New Orleans. The review of the DDRs for the sluice gate, closure wall, and pump station focused on the hydrologic and hydraulic engineering aspects of the project elements.

### Mechanical Engineering Review Approach

The mechanical engineer reviewed the DDR and other materials provided before the August 2009 orientation and site visit to develop an understanding of the planned project scope, the project design criteria, and the requested scope of the IEPR. The panel member concentrated on understanding the overall project operating plan; the function of the pumping, navigation, and flow control equipment; and the provisions for backup or redundant equipment in the event of any system or equipment failure.

The HSDRRS Design Guidelines (dated October 2007, with revisions dated 12 June 2008) were used as a reference for the IEPR panel member's assessment of the mechanical systems and equipment design goals as stated in the GIWW WCC DDRs. The design assumptions, criteria, and operating plans described in the design calculations and documentation were reviewed for consistency with each DDR's stated requirements. The reviewer focused additional attention on the large sector gate arrangement and design due to its very large size (where few precedent designs are available for reference). Similarly, the pump station's engine-gearbox-pump concept was reviewed in more detail, due to its unusual arrangement and large pump size. The mechanical engineer examined the project drawings, specification, and calculations mainly to

confirm that the DDR requirements had been carried out. The DDRs were reviewed with respect to best practices in engineering and the HSDRRS Design Guidelines (October 2007).

IEPR comments were developed and entered into the DrChecks format. Comments were discussed with other members of the IEPR team, followed by review and response to comment replies provided by the WCC design and construction team.

#### Materials Engineering Review Approach

When reviewing the DDRs, the materials engineer focused on the selection of construction materials, method of preparation, placement of concrete, and quality control of the placed concrete for all five major features of the GIWW WCC project to ensure both short- and long-term durability of the concrete. Specifically, the reviewer drew on his expertise on the constituents of concrete to ensure that any short- and long-term chemical reactivity of the components that could adversely affect structure durability was avoided. In addition, methods of concrete preparation and measures taken to ensure structural soundness by using fresh concrete with controlled temperatures was also reviewed.

#### Electrical Engineering Review Approach

The electrical engineer concentrated on understanding the project purpose, existing project features, and site characteristics that influence electrical design issues. The HSDRRS Design Guidelines (dated October 2007, with revisions dated 12 June 2008) were reviewed with respect to her background and experience. Also reviewed were USACE engineering regulations, manuals, guidelines, and technical letters for flood and hurricane protection pertinent to electrical features.

#### Civil Engineering and O&M Engineering Approach

The civil and O&M engineer approached the IEPR review first by reviewing the HSDRRS Design Guidelines (dated October 2007, with revisions dated 12 June 2008) and the USACE engineering regulations, manuals, guidelines, and technical memorandums for flood and hurricane protection, including their application to the specific requirements of the hurricane risk reduction of Greater New Orleans. The project background, design, operations, and history were also reviewed, including operations, maintenance, and performance of the existing structures during recent hurricanes. The design assumptions, criteria, and analyses contained in the DDRs provided were reviewed for completeness, applicability, and conformance with the project goals and objectives. The constructability was reviewed with respect to cost effectiveness, schedule, and, in particular, the need to maintain access and maintain or re-establish hurricane protection as conditions warrant during construction.

### 4.2 Summary of IEPR Panel Member Comments

This section provides a breakdown by category of the types of comments and the USACE evaluation responses.

The IEPR Panel's comments on the GIWW WCC IEPR project were categorized as either critical or non-critical. Of the 384 comments generated, 128 were identified as critical. For each IEPR Panel comment, USACE had the option of evaluating the response as either "Concur," "Non-concur," "For Information Only," or "Check and Resolve." Table 5 indicates, by

discipline, the number of USACE evaluation responses in each category as well as the number of critical comments.

**Table 5. Total Comments and Evaluation Responses for all Five Features**

| Discipline | Total Comments | Critical Comments | USACE Evaluation | | | |
|---|---|---|---|---|---|---|
| | | | Concurred | Non-Concurred | For Information Only | Check and Resolve |
| Geotechnical | 224 | 67 | 185 | 9 | 28 | 2 |
| Structural | 51 | 10 | 38 | 5 | 8 | 0 |
| Mechanical | 16 | 5 | 12 | 2 | 2 | 0 |
| Electrical | 14 | 0 | 8 | 0 | 6 | 0 |
| Hydraulic | 18 | 14 | 16 | 1 | 1 | 0 |
| Civil | 14 | 6 | 6 | 6 | 2 | 0 |
| Materials | 19 | 19 | 7 | 8 | 4 | 0 |
| O&M | 28 | 7 | 19 | 0 | 8 | 1 |
| Total | 384 | 128 | 289 | 55 | 61 | 3 |

Based upon the discussions during the IEPR teleconferences, at the final face-to-face meeting, and during the subsequent close-out of DrChecks comments, the USACE PDT was in general agreement with majority of the Panel's concerns (75 percent of the comments received USACE PDT concurrence).

## 4.3 Discussion

This section discusses the issues that the Panel identified as important or critical to the success of the GIWW WCC project. General overarching comments made by the IEPR Panel are discussed first, followed by feature-specific comments for the pump station, large sector gate, 404(c) wall, closure wall, and sluice gate, respectively.

### 4.3.1 General Overarching Comments

The following comments are general in nature and applicable to the review of the DDRs for all five of the major features of the GIWW WCC project:

- In the May 2010 IEPR project update and briefing, the IEPR Panel learned that a significant amount of design and construction had occurred that was not subjected to the IEPR process. While the USACE PDT concurred, it cited time constraints and the desire to prevent design and construction delays as reasons for proceeding without performing IEPR activities. In closing the comment, the IEPR Panel noted the concerns and expressed non-concurrence because initiation of IEPR activities was not dependent on completion of the DDRs, especially for many of the geotechnical engineering design, analysis, and construction issues.
- Time constraints were cited as the reason why certain activities were not performed during construction. For example, the large sector gate's temporary cofferdam used spiral-welded pipe (SWP) piles as load-carrying members in its construction. This was one of the first applications of such piles for this purpose by USACE on HSDRRS projects. Therefore, for a variety of technical reasons, an IEPR panel member commented that time constraints were not sufficient to preclude follow-up

pile driving analyzer work on selected production piles. The IEPR Panel closed the comment because the IEPR review was conducted after construction occurred, so the USACE PDT could not make modifications to the monitoring program for these piles. Furthermore, USACE PDT personnel indicated that the pile driving analyzer would be used to monitor and document pile installation.

- Early on during the IEPR, the IEPR Panel was instructed to review the DDRs and to use the appendices for reference only. The Panel commented that under this restriction, a proper engineering review could not be conducted, and that fact-based opinions about the adequacy and appropriateness of the engineering parameters, the analytical approaches, and the results used to guide design and construction could not be formulated. Following discussions in DrChecks and in a September 2010 teleconference, the USACE PDT agreed that reports from project consultants and the reports' appendices were part of the DDRs and should be reviewed as part of the IEPR. Given this answer from the PDT, the IEPR Panel closed the comment and thereafter, IEPR activities included reviewing the DDRs, appendices, other supplemental documents, and follow-up commentary provided through the DrChecks process.
- Some questions arose about the ECI process itself, and what was learned and changed by the design team as a result of the use of the ECI process. There also were concerns that the ECI involvement occurred too late in the process to be effective. The USACE PDT responded that the award to the ECI contractor was made early in the design process and was effective as it resulted in incorporating changes in the design. In closing the ECI related comments, the IEPR Panel suggested that the PDT provide greater documentation of the process in log format and assure that design changes be included in the final DDR. The Panel believes those lessons learned could be very beneficial to future design teams assigned to work on similar projects.

- During the review of the DDRs, the IEPR Panel commented that the level of detail was on occasion insufficient to make evaluations and formulate opinions about the adequacy or appropriateness of the analysis and design as required. In support of those comments, ER-1110-2-1150 was cited. Following discussions in DrChecks and in the September 2010 teleconference, USACE evaluators agreed that the content and level of detail presented in the DDRs would be enhanced. This USACE evaluator comment addressed the Panels' concerns and the related comments were closed. The agreement to enhance the content of the DDR's resulted in additional clarity and better documentation for many aspects of the project documents. Specifically, this resulted in better documentation, descriptions, and discussions of critically important geotechnical issues such as:
    - Area and site geology
    - Stratigraphic profiles
    - Field and laboratory data interpretation and data validation methods
    - Parameter selection, including data sources and selection rationale
    - Assumptions and their implications and limitations on design, construction, and performance

- Sources of information and citations of important supporting or supplemental studies and references

- The IEPR Panel inquired about the types of cement being used for the project to ensure that Type III cement is avoided in these water control structures because Type I/II was specified in the project specification documents. The panel members drew attention to the specification of both types of concrete to ensure that tricalcium aluminate ($C_3A$) content in any Type I cement used in place of Type II would be less than 8 percent. USACE provided assurances that Type II cement was used in all project phases. Given this assurance the IEPR Panel closed the related comments.

- The IEPR Panel questioned the combinations of cement, fly ash, and blast furnace slag used. The Panel indicated that some proportions of the cementitious components used on the 404(c) wall favored the use of higher mineral admixture. In the opinion of the panel members, the durability of the concrete could be best ensured with lower proportions. References were provided by USACE from the American Concrete Institute (ACI) to support the higher proportion used. The rationale for the higher proportion of the mineral admixture was to control high temperature in mass concrete components of the structure. The IEPR Panel accepted the opinion of ACI and closed the comment.

- The IEPR Panel expressed concern that the Estelle Water Control Structure was intended to be operated manually during a storm event rather than remotely. If, for some unforeseen reason, this structure is not closed at the proper time, the integrity of the entire complex will be compromised. The USACE PDT commented that there will be back-up control systems for closure of the sector gate, and the comment was closed.

- The IEPR Panel recognized that effective system performance is directly affected by how the individual project features/components are operated in concert with each other and how they are maintained. The IEPR panel members therefore believe that the production of an O&M Plan/Water Control Manual that clearly describes the operational triggers and protocols is essential and should be subject to the IEPR process. The USACE PDT provided assurance that the O&M manual would be subject to IEPR review, and the comment was closed.

- The IEPR Panel was concerned about the long-term viability of the GIWW WCC system with regard to O&M and asked who will be the O&M entity. USACE responded that the Coastal Protection and Restoration Authority (CPRA) of Louisiana (State of Louisiana agency) is the non-Federal sponsor for this project. As such, the CPRA will be responsible for long-term O&M. The Panel recognized that the State of Louisiana agency has an impressive record of water management achievement, but lacked experience with operating a pump station or sector gate as large as those proposed for the GIWW complex. The Panel agreed that the CPRA was a capable O&M entity and closed the comment.

- The IEPR Panel raised questions regarding connections between the individual project components, such as the 404(c) wall and the sector gate, all of which were answered by

the project designers appropriately and professionally. In closing the related comments, the panel members further noted that such concerns/questions are not uncommon while reviewing 95% documents.

### 4.3.2 Pump Station Comments

The GIWW WCC is one of the largest pump stations ever constructed by USACE and one of the largest ever constructed in the United States, both by size of structure (over 600 feet long) and in pumping capacity (19,140 cfs). This topic was well discussed during the IEPR. The IEPR design review focused on the 100% DDR and included site visits. The following major issues were raised in DrChecks during the review of the Pump Station DDR:

- The IEPR Panel had questions about having plans designed to handle flotation of a partially constructed structure in the event of a major flood. USACE responded that preventing flooding or flotation during construction is the responsibility of the contractor, and the comment was closed.
- The IEPR Panel questioned what thermal analysis was performed for the very large foundation and wall concrete pours to determine reduced pour heights or additional reinforcement for crack control in the mass placements. USACE responded that a master specification for structural and mass concrete was developed through the ECI process for the entire project and the comment was closed.
- The IEPR Panel questioned why protective pile dolphins were not used. USACE responded that such protection systems would be designed by the Mississippi Valley Division , New Orleans District (MVN) for upstream and downstream of the pump station. The comment was closed by the Panel with the understanding that MVN would include that documentation in the final DDR and that an independent review of that section would be performed by the team or another party.
- For the 100% Pump Station DDR, the IEPR Panel was concerned that the total hydraulic capacity of the pump station was stated differently in different places in the DDR and was apparently less than the total pumping capacity of the local parish pumping stations contributing to the project. After additional documentation was provided and reviewed, and after extensive discussions with USACE personnel were held, the review comments were addressed and the comments were closed. Specifically, the inconsistencies in the total hydraulic capacity of the pump station were corrected. In addition, additional material justifying the corrected pump station capacity was provided and reviewed.
- The IEPR Panel considered the risk of a fuel-driven fire and smoke event in the pump station and safe house. Comments related to ventilation and personnel safety in the safe house were resolved by responses provided by USACE and the comments were closed. Considering its importance, fire protection was considered during the construction site visits.
- The IEPR Panel noted the 100% Pump Station DDR was silent on the design of the pump station sluice gates. The USACE responses in DrChecks provided a clear description of the design requirements for the sluice gates, and the panel members understand these sluice gate design criteria will be added to the Pump Station DDR. The panel was satisfied with the USACE response and the comment was closed.

- The IEPR Panel made several comments related to electrical issues during the review of the Pump Station DDR. The primary electrical issues involved adequate redundancy in the utility service, the physical protection of the fuel supply and electrical service to ensure continued service during a storm event, and maintenance of communication facilities. Issues were communicated through DrChecks, and the panel members were satisfied that proper consideration was given to providing adequate electrical and communication systems to serve the pump station and the related comments were closed.

### 4.3.3 Sector Gate Comments

The GIWW WCC sector gate is the largest sector gate structure ever constructed in the United States, which presents challenges in design and construction. For the sector gate design, the panel members reviewed the 95% DDR. The following are the major issues raised in DrChecks during the review of the Sector Gate DDR:

- The IEPR Panel questioned why the Preliminary – 95% Submittal of the DDR rather than a more final version was being reviewed since construction was well under way. The USACE responded that the DDR would not be finalized until construction is completed for inclusion of any final changes. The comment was closed by the reviewer.
- The IEPR Panel questioned whether any thermal analysis had been performed for the 10-foot-thick base slab to determine if additional crack control reinforcement or reduced pouring sequence should be provided. The PDT responded that the CTL Group had provided the thermal analysis and provided additional explanation in its response, and the Panel closed the comment.
- The IEPR Panel questioned whether any model testing had been performed on this large sector gate, since the gate is 10 times heavier than typical gates in the United States and since buoyancy tanks are being utilized. Methods for confirmed reliability for such a large gate performing in service conditions were also questioned. The PDT responded by providing additional text to be added to the DDR that contained supportive information for the design and construction process and the Panel closed the comment.
- The IEPR Panel requested that more information be provided on other cofferdam types and schemes that were investigated or considered, noting that the DDR should serve as a paper trail for the design and analysis process. In addition, the Panel questioned whether any in-the-wet schemes were considered or ECI revisions made. The PDT responded that more DDR information is not necessary because cofferdams are temporary construction and that the ECI contractor did not suggest any in-the-wet techniques, so none were investigated. The comments related to the cofferdams were closed by the Panel.
- A series of comments related to clarifications or inconsistencies between the drawings, specifications, and the DDR were made on the drawings of the hinge, bearing, and bracket assembly on the sector gate and were mostly minor; those comments focused on constructability and provisions for future gate maintenance. The final construction of the hinge and bearing resolved these comments, as described by the USACE responses to the panel member's comments in DrChecks. Based on these responses, the Panel closed the comments.

- The IEPR Panel made several comments related to electrical issues during the review of the Sector Gate DDR. The primary electrical issues involved the completeness of the electrical calculations to demonstrate adequate service capacity, the physical and electronic protection of the system to ensure continued service, and adequate, efficient lighting of the facilities. Issues were communicated through DrChecks, and the Panel closed the related comments satisfied that proper consideration was given to providing adequate electrical and communication systems to serve the sector gate.

### 4.3.4 404(c) Wall Comments

The following are the major issues raised in DrChecks during the review of the 404(c) Wall 100% DDR:

- The IEPR Panel commented that for better documentation in the DDR and a more complete paper trail, the DDR should contain a number of plates or sketches and key references to contract plans (to serve as more of a stand-alone document). USACE responded that complete design drawings will be added to the final DDR and the comment was closed.
- The IEPR Panel was concerned about how the construction of the ~4,000-foot-long wall would be sequenced and suggested that information on checkerboard placements, starting/ending point locations, pouring frequency, etc., preferred by the PDT/ECI Contractor should be added to the final DDR. The USACE PDT responded that such information would be added. The panel members requested to see the additional discussion and closed the comment.
- The IEPR Panel questioned the analysis of expansion and contraction along the ~4,000-foot-long wall and justification for only one-half-inch expansion joints between monoliths. Joint details are shown on the contract plans, but no text is provided in the DDR. USACE responded that expansion joint details and monolith lengths are in accordance with the HSDRRS Design Guidelines, no thermal analysis was performed, and special methods are not required for expansion control. USACE further stated that information will be provided in the final DDR and the Panel closed the comment
- The IEPR Panel was concerned by the lack of design documentation in the DDR for the protective steel dolphins, which are a critical element for the protection of the 404(c) wall. USACE responded that the dolphin designs were covered in a separate design package (WBV-90Q) not provided to the Panel. The IEPR Panel accepted the USACE response and closed the comment.

### 4.3.5 Closure Wall Comments

The closure wall acts as the tie-in to both the 404(c) T-wall and the large sector gate west abutment and as such connects two very different project components. The IEPR Panel reviewed the 100% DDR, and the major issues discussed in DrChecks from the review are as follows:

- Because the temporary cofferdam piling is planned to be reused for the permanent combination wall, the IEPR Panel was concerned about the acceptance criteria for the reused sheet and SWPs. The USACE PDT provided an explanation in DrChecks of the

processes for cleaning, inspection, and acceptance per dimensional tolerances that are covered on the plans and in the technical specifications. The Panel accepted the USACE explanation and closed the comment.

- The IEPR Panel asked whether corrosion protection should be provided on the temporarily exposed steel structure above El.-1.5 until it is encased in concrete for the permanent structure. The USACE PDT stated that no corrosion protection was necessary for that portion of the structure because it will be in place only for interim protection, the anticipated exposure period will be less than 1 year, and the structure will then be removed for installation of the permanent structure. Given this response, the Panel closed the comment.
- The IEPR Panel had several comments concerning the comparison performed between Alternatives 1 through 4, stating that more detail and clarifications were necessary to explain the selection process. Furthermore, an Alternative 5 was dismissed without further discussion. Additional information and justifications were included in the PDT's response in DrChecks. The panel member suggested adding the additional information in the DDR and closed the comment.
- The IEPR Panel had specific safety concerns with the timing of cutting the interim closure wall during the summer of 2011. The USACE PDT noted the concern and stated that the schedules for that activity would be negotiated. In closing the comment, the panel members recommended that the final schedule be negotiated as close to November 30 as feasible in order to maximize protection during the hurricane season.

### 4.3.6 Sluice Gate Comments

The sluice gate provides a method to reduce the water velocity through the large sector gate while it is open and was observed by the panel members to provide operational flexibility. The Panel identified the following comments as important during their review of the Sluice Gate 95% DDR:

- The design of the sluice gates themselves was not included in the DDR, and the IEPR Panel requested that this information be added. The PDT noted that the original specification required cast iron gates that met a performance specification, however, the contractor submitted an alternative stainless steel gate constructed of welded built-up members. New calculations for the stainless steel gate designed by the contractor were submitted and approved by the USACE PDT, and this information will be included in the final DDR. The Panel appreciated the complete response provided by the USACE and closed the comment.
- The IEPR Panel questioned whether the design and DDR documentation should include information on debris impact, since the planned protection dolphins may not prevent that load case from occurring. The USACE PDT responded that a debris impact load of 0.5 kip per linear foot would be added to the DDR and the Panel closed the comment.
- The IEPR Panel requested an explanation on the 3-inch expansion joint requirement noted in the DDR and shown on the plans. In response to the request, USACE PDT provided a detailed explanation in DrChecks of how the 3-inch expansion joint

requirement was arrived at. In closing the comment, the Panel suggested adding the description provided in DrChecks to the DDR for clarity.

- The IEPR Panel asked whether a thermal analysis was performed for sluice gate pours greater than 4 feet thick. The USACE PDT explained its use of the Level 2 analysis per ETL 110-2-542 and provided information to be included in the updated DDR. Given this additional information, the Panel closed the comment.
- The IEPR Panel noted the omission of governing loads for the concrete base slab design, while such information was provided in subsequent DDR sections. The USACE PDT stated that it would provide that information along with accompanying calculations in the updated DDR. Based on this response the Panel closed the comment.

### 4.4 Critical Comments and Other Open Issues to be Resolved

The IEPR teleconferences and face-to-face meeting were an effective format to communicate and discuss the IEPR panel members' understanding of the technical details of the project. The teleconferences and face-to-face meeting were critical components of the IEPR process, especially since there was no unmonitored e-mail or additional telephone contact between the USACE PDT and the IEPR panel members. During the face-to-face meeting and teleconferences, all unresolved issues were discussed. However, at the conclusion of the review, the Panel still disagreed with the USACE response on several issues. For those issues upon which the Panel did not agree with USACE, the panel members provided a final BackCheck response before closing the comment. All comments were closed by the end of the IEPR.

## 5 CONCLUSIONS

The panel member selection process (using predefined technical and conflict of interest standards) and the IEPR process were conducted in strict compliance with USACE peer review guidance documents (see Section 1.1) and the Battelle PRQCP.

Upon initiation of the IEPR for the GIWW WCC, the IEPR Panel attended a USACE orientation briefing and boat tour of the GIWW WCC site. Immediately after the site visit, the IEPR panel members created their CILs, focused on resiliency, redundancy, and robustness. The IEPR effort was placed on-hold while the USACE PDT performed a reevaluation of the GIWW WCC project. Upon IEPR continuation, the USACE PDT briefed the IEPR Panel on the current project status including that the design documents were nearly complete and that significant construction had occurred.

The IEPR Panel was provided with copies of the DDRs and supporting documentation for each of the five main features of the GIWW WCC project. During the review of those documents, the IEPR panel members generated 384 comments and identified 128 (33 percent) of those comments as critical. Comments went through one round of evaluations by the USACE PDT and one round of BackChecks before being discussed during two teleconferences and a face-to-face meeting held at the USACE District office in New Orleans, Louisiana.

The IEPR panel member comments generally fell into the following categories:

- Ensuring consistency throughout all documents
- Requesting that additional material be added to the DDRs to provide a more complete analysis or paper trail
- Providing further explanation of construction methods, materials, and timing

In addition, the IEPR panel members expressed concern regarding the timing of the IEPR process. The IEPR was initiated after the documents were substantially completed and construction was well under way. The USACE PDT cited schedule pressures as the reason for the timing of the IEPR process. The IEPR panel members felt that there were missed opportunities to provide critical input to the design documents for elements already constructed. Various critical installation issues involving the use of SWP piles in a manner not originally considered were provided as one example.

Also of concern was the lack of O&M manuals for review. The IEPR panel members recognize that effective system performance is directly affected by how individual project system features/components operate in concert with each other and how they are maintained. The IEPR panel members therefore are convinced that the production of an O&M Plan/Water Control Manual that clearly describes the operational triggers and protocols is essential and should be subject to the IEPR process. Due to contract vehicle limitations, the USACE PDT assured the panel members that the O&M manuals would undergo an IEPR via a separate contract.

Overall, the IEPR Panel appreciated the significant effort required to design and construct the GIWW WCC project—a project of unprecedented size with many complex and unique features. The IEPR panel members are satisfied with the documented analytical and design approaches for the GIWW WCC project and elected to close all IEPR comments.

# APPENDIX A

# GIWW WCC IEPR Charge

General Charge Guidance

For a Type II IEPR, the design and construction phases, the Safety Assurance Review should focus on unique features and changes from the assumptions made and conditions that formed the basis for the concept design. The panel should address the following questions:

1. Do the design assumptions made during the decision document phase (interpreted as the EAR, PDD, DDR, or similar appropriate design document for the specific project--to be provided to panel) for hazards remain valid through the completion of design as additional knowledge is gained and the state-of-the-art evolves?
2. Do the project features adequately address redundancy, robustness, and resiliency?
    (1) Redundancy. The use of multiple lines of defense that are linked to potential failure modes. The most vulnerable failure modes need the greatest redundancy.
    (2) Resilience. The use of enhancements to improve the ability of the system to sustain loads greater than the design load to achieve gradual failure modes over some duration rather than sudden failure modes.
    (3) Robustness. The use of more conservative assumptions to increase capacity to compensate for greater degrees of uncertainty and risk.
3. Do the design assumptions made during design remain valid through construction? (Final DDRs, CO QMPs, site visits, and other similar appropriate documents to be provided to panel for this assessment.)