CEMVN-ED-E

MEMORANDUM FOR: Commander, Mississippi Valley Division

SUBJECT: Independent External Peer Review of the Greater New Orleans Hurricane and Storm Damage Risk Reduction System, LPV 109.02a – New Orleans East Levee, Southpoint to CSX Railroad

1. Reference the Final Independent External Peer Review (IEPR) Report, April 18, 2012 and CEPCX-CSDR subject memo dated June 26, 2012 endorsing the IEPR and transferring the disposition of the IEPR to the New Orleans District (MVN).

2. The IEPR of the Greater New Orleans Hurricane and Storm Damage Risk Reduction System, LPV 109.02a – New Orleans East, Southpoint to CSX Railroad Report (April 2012), was conducted from May 2011 through June 2012. The independent team consisted of four (4) Panel Members from four (4) major engineering disciplines; geotechnical, structural, civil, and hydraulic. The IEPR effort included an Orientation Briefing, Construction Site Visit, Placement of Panel Review Comments into Dr Checks, Comment Review Teleconference, and Submittal of Draft and Final Reports.

3. A total of 48 comments were submitted by the IEPR Team. Of the 48 comments provided by the IEPR panel members, 23 comments were identified as 'critical', defined as pertaining to any critical component, subcomponent, or system whose malfunction can cause a failure of a structure or cascading failure of the entire system and pose a risk of serious injury, loss of life, or loss of mission objectives. The USACE PDT evaluated each comment and provided a response that included specific revision that will be made to the LPV 109.02a Report as appropriate.

4. The following comments from the IEPR Report by the reviewers are summarized below to highlight what they consider the most important items to be addressed. The summarized comments from the report are reproduced here in italics followed by the USACE PDT response.

    a. *The IEPR Panel questioned the accessibility and operation of sluice gates located on the flood side of the levee crest that control drainage structure flow. These drainage structures are RCP culverts designed to allow excess water to flow from the protected side (Bayou Sauvage NWR) to the flood side when the water levels allow. During a storm event, it may be difficult to access this gate because of high water, wind, and waves.*

A representative from the State said that the structures would probably be closed two days prior to landfall and weather would permit them to access the gates at that time. The Panel was satisfied with this response and the comment was closed.

b. *The IEPR Panel had several questions about the four drainage culverts that allow movement of water from the protected side (Bayou Sauvage NWR) to the flood side when the water level on the protected side is high and the water level on the flood side is sufficiently low. There is a possible loss of integrity of the levee system due to the piping and control system. The panel members requested clarification that gates and the culverts are performing properly during flood events.*

   The USACE PDT stated that the primary means of protection are the sluice gates and that they are protected from being struck during a storm event, and that access is restricted by locks on the grating. Flap valves installed on the flood side provided secondary protection, but may be damaged during a storm event. USACE also clarified questions on how the flow rate through the culverts would be controlled. As far as O&M for the piping and controls, USACE noted that periodic inspection should detect the need for preventive maintenance and repairs. Based on this response, the Panel closed the comment.

c. *The IEPR Panel asked if the design considered possible damage from barge impact on the flood side. Possible failure mechanisms from an impact may include: (1) breaking the flap gate, thereby allowing water to enter the culvert and possibly flow to the protected side, and (2) rupturing the culvert, thereby allowing water to flow from the culvert into the surrounding soils of the levee.*

   The USACE PDT stated that flowable fill (light concrete) was added during construction at the haunch areas of the pipes, improving the permeability. In the event of a rupture, likely to happen between the sluice gate structure and the outlet discharge on the flood side, the sluice gate should minimize any water flow into the surrounding levee soils. The IEPR Panel accepted the USACE response and closed the comment.

d. *The IEPR Panel questioned the magnitude of the barge impact load used for T-Walls (I.e., only 50 kips).*

   The USACE PDT explained that the highway crossings fall within category #2, which are the impact loading from a pleasure craft (i.e., 50-kip). The transition between #2 (50 kip) and #1 (100 kip) occurs at the southeastern-most point in the New Orleans East System, where east-west floodwalls along the Intracoastal Waterway (#1) meet the north-south walls along the east edge of the levee protection (#2). Tie-in to another project (LPV 110) used the 100-kip barge impact load to match the criteria created for that specific project. The IEPR Panel accepted the USACE response and closed the comment.

e. *The IEPR Panel questioned the magnitude of the barge impact load used for one of the gates or the earthen levee. The Panel felt that the result of the failure of the gate due to a barge impact can be as great as the failure of the T-wall under similar impact loading.*

The USACE PDT explained that gates are designed for a minimum of 50-kip boat impact load and cited the location of the design and load combination criteria for the design of boat/barge impacts for the gates in the documentation. The IEPR Panel accepted the USACE response and closed the comment.

f. *The IEPR Panel asked what the consequences would be of another type of impact such as a car or train crashing into one of the gates (from either the protected or the flood side) during or after closure. The IEPR Panel also suggested the types (e.g., reinforce/replace/repair) of mitigation in place so that flooding is controlled should be discussed.*

The USACE PDT referenced drawings in the LPV 109.02c project for details of the gate closure signal and barricades placed on the flood side and protected side of the gate. Because the potential failure mode(s) of gates are not a part of the LPV.02a project, the Panel recognized the issue was not part of their review, and closed the comment.

g. *The Panel was concerned with the lack of information on the gates at the crossings with regard to operational details for maintaining, monitoring, and testing to ensure that the gates and the culverts perform properly during flood events.*

A representative from the State provided the IEPR Panel with quarterly inspection sheets for the gates (communicated through Dr Checks). Furthermore, USACE said they were preparing O&M manuals for all portions of the HSDRRS, including a formalized O&M procedure for floodgates within that manual. The Panel said that assuming that this improved, system-wide O&M process is completed and implemented, the concern is resolved and the comment was closed.

h. *The IEPR Panel requested confirmation that failures at the proposed transitions from T-Walls to earthen levees will not occur due to differential settlement or erosion.*

The USACE PDT explained how the design and construction of the transitions from T-Walls to earthen levees is supported. Deep mixing method (DMM) elements as well as high-strength geotextile over the DMM and the earthen levee provide a measure of mitigating differential settlement. The IEPR Panel accepted the USACE response and closed the comment.

i. *The IEPR Panel requested that pile-driving criteria be included in order to confirm pile capacity and production pile quality control.*

The USACE PDT concurred and said they would add a note about timber piles to the plans and specifications; however, there was enough information about the timber piles to complete the construction of the pump stations without any delay.

j. *The IEPR Panel commented that the Design Documentation Report (DDR) provided design criteria and recommendations for pile capacities/factors of safety for piles with and without load tests; however, the specifications do not provide pile-driving criteria (tip elevations only?), means for confirming pile design capacity /information, or production pile quality control.*

The USACE PDT responded by stating that piles were driven to the specified tip elevation and that pile capacity for a FS=3 does not require confirmation. QC is upon the contractor and QA is upon the USACE field personnel as required in the specifications. The IEPR Panel accepted the USACE response and closed the comment.

k. *The IEPR Panel commented on the settlement of soft clays that exceed the overbuild height. If only 2 feet of overbuild is planned, then the levee height will be 7 inches short of the 1% storm event requirement at the crest; therefore, what plan or schedule is in place to correct this deficiency?*

The USACE PDT explained the measures they have taken to address this issue. Additional fill has been applied to Sub-Reach 2 and USACE will continue to monitor this. Additional fill may be added before the contractor leaves the site. USACE also responded that annual monitoring of the crest of the levees has been recommended to ensure that all elevations do not fall below 2011 design elevations. The Panel accepted the USACE explanation and closed the comment.

l. *The IEPR Panel was concerned that without armoring or even consideration of the erosion potential, there is opportunity for a failure mode from the protected side due to overtopping, as some overtopping may occur even with the 1% chance event.*

The USACE PDT stated that current design entails limiting the overtopping of protections that occur in the 1% event to a quantity that can be carried by typical turf covering. The panel members requested additional clarification to see evidence where erosion protection to protect against overtopping during the 1% event has been incorporated. USACE clarified that erosion studies have been performed and concluded that grass cover will protect the levee against erosion for overtopping during a 1% event. The Panel appreciated the detailed response provided by the USACE and closed the comment.

m. *The IEPR Panel requested an explanation on the need for additional armoring given inconsistent overtopping rates for the LPV 109.02a levees.*

The USACE PDT explained that recent wave overtopping testing at Colorado State University withstood much higher wave overtopping flow rates and was successfully compacted to the HSDRRS Design Guidelines. Given this additional information, the Panel closed the comment.

n. *The IEPR Panel requested that the correct Uplift Load Diagrams be used in the design calculations for both the "Impervious" and "Pervious" sheet pile cut-offs, as they do not match the recommended Uplift Load Diagram in the HSDRRS Design Guidelines. The USACE PDT said it was determined that neglecting the protected-side uplift would result in a more conservative analysis and that uplift on the protected side of the monolith was ignored to amplify the effects of overturning due to flood-side hydrostatic force and flood-side uplift force. The Panel asked for additional clarification about the Uplift load on the protected side, as it may or may not be conservative for all the design load cases.*

   The USACE PDT and its contractor clarified that no simplifications were adopted on the "Uplift Load Diagram." HSDRRS Design Guidelines only shows the case when the water level is above the bottom of the base slab at the protected side (not the case for this project); instead, a linear distribution of the pressure on the bottom of the slab from zero in the protected side up to the uplift value in the flood side is used. Historical hydrologic data for the area show that groundwater on the protected side of the alignment rarely rises above the elevation in question (EL 4.0). If the water level is higher than EL 4.0, the protected side will be flooded. Whether impervious or pervious, all of the load cases presented in the calculations, with the exception of the construction cases, will result in a slightly more conservative analysis when protected-side uplift is not present, especially considering that the protected-side water level is beneath the bottom of the base slab. The Panel requested that this explanation be included in the design file(s) and closed the comments.

o. *The IEPR Panel requested that the design for all monoliths include all applicable load cases and combinations described since it appears that the unbalanced load was considered for some and ignored for most cases.*

   The USACE PDT agreed that the description of load cases for the transition to LPV 110 monoliths is confusing, explained why they were written this way, and explained why it was generally not called out in the load case descriptions table. In the design calculations for monoliths T-13, T-14, and T-15, the unbalanced loads for both the Still Water Level (SWL) and Resiliency cases have been included in all relevant analyses. The Panel closed the comment and noted that the clarification should be added to the design file(s) to make it easier for any engineer to follow the design calculations.

p. *The IEPR Panel requested that the design for all monoliths include all applicable load cases and combinations described since it appears that the "Water to Reverse Head Plus Wind" load cases were not included in the design.*

The USACE PDT stated that this load case was neglected by inspection, as it does not govern the design. The reverse water level is expected to be below the bottom of all the T-wall base slabs for this project. The Panel closed the comment, but requested that the basis for neglecting this load case be included in the design files.

q. *The IEPR Panel requested that the correct barge impact load of 100 kips be used for all monoliths.*

The USACE PDT explained that the highway crossings fall within category #2, which is impact from a pleasure craft (i.e., 50-kip). The transition between #2 (50 kip) and #1 (100 kip) occurs at the southeastern-most point in the New Orleans East System, where east-west floodwalls along the Intracoastal Waterway (#1) meet the north-south walls along the east edge of the levee protection (#2). Tie-in to another project (LPV 110) uses the 100-kip barge impact to match the criteria created for the LPV 110 project. The IEPR Panel closed the comment, but said the use of term "boat impact" instead of "barge impact" in the design calculations would be more appropriate, if the design was based on the "pleasure craft" impact loading.

r. *The IEPR Panel requested clarification as to why certain overstress factors were not used for specific T-Wall load cases.*

The USACE PDT said the table the Panel was using was for the monolith foundation calculations. The overstress factors listed in this comment are for wall designs, not foundation designs. The Panel member requested additional information from USACE, as the table does not mention anywhere that the load combinations are for the foundation design. USACE stated that due to an accidental omission, the load combination table in question was named "T-Wall Monolith Load Combinations" and not "T-Wall Monolith Foundation Load Combinations," and assured the Panel that all overstress factors used in the design calculations are properly applied to foundations and T- walls per the HSDRRS Design Guidelines. The IEPR Panel closed the comment, but said the clarification should be included in the design file(s).

s. *The IEPR Panel noted some inconsistencies in elevations in the DDR.*

The USACE PDT agreed and verified the correct elevations that should be listed and provided an updated file (through Dr Checks) of stem wall calculations. Additionally, USACE explained that the flood walls at this crossing are in a stair-step pattern, and T-12 is at the top of the slope. The SWL (EL. 12.5) is below the top of the slab for monoliths T-7 and T-12 because of the stair-step pattern. The Panel appreciated the responses and closed the comment.

t. *The IEPR Panel was concerned that incorrect barge/boat impact load magnitudes and load distribution patterns were used throughout the design, notably in the "Impact Load Application and Distribution" in the design documents.*

The USACE PDT responded that perhaps the wording of the General Notes in the Stem Wall Design Calculations could have been more clearly expressed to say that the load is still applied horizontally, but that the distribution width becomes larger as you analyze sections farther down the wall. USACE PDT also provided a sketch for a visual of how the barge load is applied in the LPV 109 calculations. The Panel still felt that the load distribution of barge impact did not seem realistic even if the barge impact load is applied horizontally. The HSDRRS Design Guidelines clearly states, "Boat/Barge impact loads shall be distributed over 5 feet **width** plus **the width** gained along a 45-degree angle" (in horizontal plane along the length of the wall). USACE responded again by saying they agree that a check of punching shear, which they believe is being expressed by the comments about distribution of the impact load along the horizontal plane, could be derived from the statements on page 5-25 of the HSDRRS Design Guidelines. However, as can be seen by the calculation (through Dr Checks, the Impact Punching Shear calculation was provided) for two-way shear due to barge impact, a 2-foot-thick wall (which is the minimum thickness for walls exposed to 50-kip and higher-impact loads) will always be able to sustain these impact forces. This may be why a specific guideline for punching shear checks was not inserted in the HSDRRS Design Guidelines, because as long as the thickness requirements set forth in Section 5.5.5 are followed, two-way shear will not be a problem. The Panel accepted the response and closed the comment, but requested that the clarification be included in the design file(s).

u. *The IEPR Panel questioned why the "Hydrostatic Force & Moment" for the load cases on all the spreadsheets are computed as "zeroes" and whether it had something to do with the still-water elevation used in the analysis.*

   The USACE PDT explained that the floodwalls at this crossing are in a stair-step pattern, and T-12 is at the top of the slope (stair). The SWL (EL. 12.5) is below the top of the slab for monolith T-12 because of the stair-step pattern. For this reason, any loads related to the SWL hydrostatic force are set to zero in this spreadsheet. The Panel accepted the response and closed the comment.

5. **Recap.** As stated in the report, "In general, the IEPR panel members agreed that the LPV 109.02a project documents contained sufficient information to provide a reasonable level of safety assurance for the project within the context of USACE's latest HSDRRS Design Guidelines. The IEPR panel members also agreed that the design assumptions made during the design phase appear to be carried forward through construction, and that the levees and structures were being built as designed. Observation of ongoing and completed construction areas was very informative during the construction site visit, notably the flowing water drainage from the wick drains through the drainage (sand) blanket. The use of the observational method (trusted but verified through monitoring, instrumentation, and in-situ testing, including CPTs) in the geotechnical design and construction monitoring appears to be reasonable and appropriate. It appears that the construction and finish (e.g.,

sedimentation and erosion control, earthwork and grading, concrete work) are of high quality and meet the project requirements."

6. **Conclusion**. The IEPR of the Greater New Orleans Hurricane and Storm Damage Risk Reduction System, LPV 109.02a – New Orleans East Levee, Southpoint to CSX Railroad Study was conducted as required and in accordance with all applicable laws and USACE regulations. At all stages of the review the peer reviewers demonstrated their command of the topics and their desire to contribute meaningfully to improvements to Corps plans and specifications that will result in greater stability and longevity of structures and embankments. They are to be commended and thanked for their service.

This memo closes out the action on the Independent External Peer Review.

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