

March 23, 2006

LTG Carl A. Strock, P.E.  
Chief, U.S. Army Corps of Engineers  
HQUSACE  
441 G Street, N.W.  
Washington, DC 20314-1000

Dear General Strock,

The External Review Panel (ERP), convened by the American Society of Civil Engineers to evaluate the work of the Interagency Performance Evaluation Task Force (IPET), is compelled to alert you to concerns raised by the findings presented in the IPET Report 2. The ERP's comprehensive review of Report 2 is ongoing and we expect to offer a number of specific technical comments in our formal report. However, with sufficient confidence in the analysis conducted by the IPET, we have reached several conclusions the gravity and potential impact of which warrant your immediate attention. We are mindful that the issues raised within this letter may extend beyond the IPET scope of work, and by extension, our own. Nonetheless, the importance of these issues obliges us to inform you of our concerns.

Two important factors contributed to the failure of the 17<sup>th</sup> Street Canal floodwall. At present, we do not know whether those factors were considered in designs at other locations. Moreover, taken collectively, decisions made during the original design phase appear to reflect an overall pattern of engineering judgment inconsistent with that required for critical structures. As a result, the ERP believes these findings present significant implications for the current and future safety offered by levees, floodwalls and control structures in New Orleans, and perhaps elsewhere. We conclude that a determination of the overall safety of the hurricane protection system cannot be made until such time as the remainder of the system can be evaluated with the benefit of this new information.

The ERP bases its conclusions on the following:

1. The design calculations for the 17<sup>th</sup> Street Canal floodwall did not account for the possibility of a gap developing on the canal side of the floodwall as the hydraulic loading on it increased, effectively slicing the levee in half. The potential for floodwalls to undergo large deformation was evident from a mid-1980s field test performed by the Corps (described in "E-99 Sheet Pile Wall Field Load Test Report," U.S. Army Corps of Engineers, Lower Mississippi Valley Division, 1988). It is clear that the Corps ultimately recognized the potential for a water-filled gap to develop. The Corps also analyzed the E-99 sheetpile wall using finite element methods to develop recommendations for I-wall design as described in Technical Report GL-89-4, "Development of Finite-Element-Based

Design Procedure for Sheet-pile Walls," September 1989, prepared by the Geotechnical Laboratory at the U.S. Army Corps of Engineers Waterways Experiment Station. Corps researchers later published a paper describing a water-filled gap, "Soil-Structure Interaction Effects in Floodwalls," by Oner, Dawkins, Mosher, and Hallal, *Electronic Journal of Geotechnical Engineering*, 1997. Because it appears that this information never triggered an assessment of the impact that such a gap would have on the stability of the existing levee and floodwall system--neither at the time of the design of the 17<sup>th</sup> Street Canal floodwall nor following its construction--the ability of any I-wall in New Orleans to withstand design flood level loading is unknown.

2. The design calculations did not account for the significantly lower shear strength of soils at and beyond the toe of the levee relative to the strength beneath the levee crest. The profession has known for decades that strengths of soft soils are significantly influenced by overburden pressure. Indeed, the Corps itself was responsible for much of the research that led to an understanding of the basic mechanics of soft soil strength. Because this important fact was not addressed in the design calculations at the 17<sup>th</sup> Street Canal, it may not have been taken into account in the design of other levees in New Orleans. Thus, the stability of levees founded on soft soils remains in question.
3. The 17<sup>th</sup> Street Canal floodwall was designed too close to the margins for a critical life-safety structure. Taken collectively, the combination of a design factor of safety at the low end of the range of appropriate values and shear strengths selected at the high end of measured values is inconsistent with a pattern of engineering conservatism appropriate for critical structures. The decision to select a design that did not incorporate scour protection is another indicator of a lack of conservatism. Such a pattern may have occurred elsewhere, and may still be occurring. Accordingly, the ERP believes that the safety offered by the levees and floodwalls in New Orleans is open to question until it can be established that a sufficiently high degree of conservatism for critical life-safety structures has been incorporated into the design.
4. While the 17<sup>th</sup> Street Canal floodwall was among several significant exceptions, many miles of levee and floodwall were overwhelmed by overtopping because Katrina exceeded the standard project hurricane. It appears that the standard project hurricane reflected the largest hurricane of record to hit the Gulf Coast, occasionally updated when an even larger hurricane struck. This approach is inconsistent with the logic used in design of structures to resist earthquake loadings or floods. In that approach, records are interpreted probabilistically and the risk is reassessed on a periodic basis. Without a statistically valid approach to determining the standard project hurricane, no rational hurricane protection system can result. The Corps is reportedly constrained by law to build levees only to authorized levels. The ERP believes that it is well within the Corps' expertise and responsibility to provide advice and recommendations on the appropriate standard project hurricane and authorized levels of protection.

Based on the findings discussed above, the ERP recommends the following actions be undertaken, with urgency, for levees and floodwalls in New Orleans and perhaps elsewhere in the nation:

- A. All I-walls should be re-evaluated for current design loadings assuming a water-filled gap along the flood side of the wall.
- B. All levees underlain by soft soils should be reevaluated for current design loadings accounting for reduced shear strength of soil in areas at or beyond the toe of the levee.
- C. All levees and floodwalls should be reevaluated to identify those areas with a questionable degree of conservatism inherent in the design process, and those sections of concern reanalyzed for current design loadings employing an appropriate degree of conservatism.
- D. A risk-based approach toward defining the design hurricane conditions is needed. We advise the Corps to proceed as quickly as possible toward redefining the standard project hurricane using principles and practices similar to those used in establishing design criteria for other infrequent but potentially catastrophic natural disasters such as earthquakes and floods.
- E. External peer review is an important component of design practice for all critical life-safety structures. We recommend that the steps described above receive external peer review throughout the design process.

Please contact us if you have questions.

Respectively submitted,

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