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September 3, 2008

LTG Robert L. Van Antwerp
Chief, U.S. Army Corps of Engineers
HQUSACE
441 G Street, N.W.
Washington, DC 20314-1000

Dear General Van Antwerp:

SUBJECT: ASCE External Review Panel
Review Comments on IPET Draft Final Volume I, *Executive Summary and Overview*, and Draft Final Volume VIII, *Engineering and Operational Risk and Reliability Analysis*

Preface

Just hours prior to issuing this letter, Hurricane Gustav made landfall in Louisiana providing one of the first real tests of the region's hurricane protection measures since the destruction that occurred during Hurricane Katrina three years earlier. Many areas in the state suffered extensive damage, but the storm's rainfall and surge impact was less than first predicted and the New Orleans metro area was largely spared the devastation seen in the aftermath of Katrina.

While the region's residents may be breathing a sigh of relief at Gustav's near-miss, they should not allow a sense of false security to settle in. New Orleans still faces a higher level of risk from flooding than would be acceptable for many other engineered life-protection systems, and another 'Katrina-like' hurricane is inevitable. The events of this week should shine an even brighter light on the need to continue improving the region's hurricane protection system, including the incorporation of risk into the decision making process at all levels.

Respectfully,

The External Review Panel

As requested, the External Review Panel (ERP) of the American Society of Civil Engineers (ASCE) has completed its review of Draft Final Volume I, "Executive Summary and Overview," and Draft Final Volume VIII, "Engineering and Operational Risk and Reliability Analysis." Both of these volumes are part of the Report of the Interagency Performance Evaluation Task Force (IPET) regarding the performance evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System dated June 2008.

The latest drafts of both Volume I and Volume VIII of the IPET report are much improved over earlier drafts. We find little to fault in these documents from a technical point of view, or from the perspective of informing the reader about the lessons learned from IPET's work. The ERP has been deeply involved in the work of IPET throughout its process. We have conveyed numerous comments to IPET throughout its investigation. We appreciate the care taken to consider our input, the professionalism demonstrated in the interactions between IPET and ERP, and the work that has been accomplished since earlier drafts.

We find that Volume I provides a detailed summary and readable account of IPET's work, the results obtained, the conclusions reached, and the lessons learned. The report is generally candid about mistakes made in the planning, design, construction, and operation of the hurricane protection system (HPS), and about the causes of the catastrophic failures during Hurricane Katrina. However, in a few places the report unnecessarily softens some of these frank assessments. For example, the summary of findings states, "The levee-floodwall designs for the 17th Street and London Avenue Outfall Canals and the IHNC were inadequate for the complex and challenging environment." The designs were indeed inadequate, and we appreciate this clear acknowledgment. The designs were flawed in several respects, described in more detail in IPET Volume V as well as in numerous recently published conference papers and journal articles. While a massive hurricane does create a "complex and challenging environment," engineers routinely are expected to design for such conditions. The fact that the design environment is complex and challenging in no way mitigates the inadequacy of the design. We suggest ending the sentence after the word "inadequate."

The description of levee failures by overtopping states that "…the structures that ultimately breached performed as designed, providing protection until overtopping occurred and then becoming vulnerable to catastrophic breaching." While accurate per se, this statement does not make the more significant and compelling assertion, which is that consideration of overtopping was not included in the design. An additional statement along the following lines would make the summary of performance more complete: "The catastrophic performance element for these breached levees was a failure to account for overtopping, which was inevitable for an extreme hurricane." In addition, some of the overtopped levees were constructed of hydraulic fill, which is typically an erodible material. Some of these levees may have been able to sustain overtopping had they been built in compacted lifts using suitable cohesive material.

Although Volume I states that the HPS did not perform as a system, it does not speak to the fact that it was never <u>designed</u> or <u>managed</u> as a system. Furthermore, on page I-2 and elsewhere, the

report refers to “datum misinterpretation and subsidence.” Perhaps a more accurate reference would be “…datum choice, misinterpretations, and subsidence…”

On balance, the issues that we might take with the report’s usage of specific words or phrases, such as the examples above, are relatively minor and number few. And they are counterbalanced by numerous clear statements about what happened, and the implications. For example, the discussion of the mistakes made in design of the 17th Street Canal, summarized on pages I-33 and I-34, while brief, appears to be complete and accurate. In addition, the fact that the elevations of the current hurricane protection system are significantly below authorized levels is acknowledged clearly – Figure 5, page I-35, is an excellent visual representation of the extent of the problem.

We particularly applaud the section, “Looking Forward,” beginning on page I-6. Here, the report assesses the information collected and lessons learned, and presents recommendations from policy to design criteria. The discussion on page I-6 about the inadequacies of the “system” is especially powerful and important. Similarly, the section “standards” correctly points out that design for a 100-year storm is fraught with risk and is not necessarily the correct de facto standard. We also appreciate the statement in “resilience” confirming that levees and floodwalls must be designed to survive overtopping. We believe the endorsement of resilient design on page I-7 should include a recommendation that provisions to protect levees and floodwalls from catastrophic failure caused by inevitable overtopping be specifically included in future congressional authorizations and appropriations.

One thing that would improve the “Looking Forward” section is to emphasize the mistake that policy makers and engineers might make in viewing all levees the same in terms of level of protection and risk – from protecting open farm land in the upper reaches of the Mississippi River, to protecting towns along the Mississippi and its tributaries, to protecting hundreds of thousands of people living in urban areas that are at or below sea level such as New Orleans. These are, the ERP believes, very different situations that require different standards. In addition, we are disappointed that there was no mention of the role and importance of external peer review in future projects.

The latest draft of Volume I contains much new information on risk, which was summarized from the comprehensive work on risk presented in Volume VIII. Volume I provides more context and a more readable style of presentation than previous drafts, and we applaud this effort to make the report more valuable to the reader. The risk analysis provides quantitative information on significant nuances; for example, the importance of both intensity and size of the storm. The results of the analyses, principally in the flood potential maps, provide a sobering reminder of the potential impacts of an enormous hurricane on the New Orleans area, and of the hazards posed to residents. Because another massive hurricane is inevitable, the quantitative risk assessment points to the need to think more intelligently about the overall system and approach toward risk mitigation.

We do believe, however, that the findings on risk need to be put into a larger context in both volumes. For example, Figure 1 (attached) presents the IPET results in a chart where the annual frequency of hurricane flooding is plotted against the number of predicted casualties. This chart shows the risk associated with the HPS pre-Katrina and as of June 2007. The chart illustrates that

the difference between pre-Katrina and June 2007, primarily due to the installation of closure gates on the outfall canals, is relatively small in comparison to what would be needed to significantly reduce overall risk in New Orleans. Also on this chart, the HPS can be compared and contrasted to international standards for large dams. While these standards for dams were not intended to be applied to levees, Figure 1 underscores the urgent need for a national dialogue to generate meaningful standards for levees.

We recommend emphasizing two major lessons learned. First, the risk is high because so many people and so much property are below sea level and are exposed to hurricanes. Second, this information needs to be better incorporated into all levels of decision-making to more effectively manage and reduce the risk – something to the effect that if risk is going to be managed effectively, then it must be assessed and considered in federal, regional, and individual decision-making. We as a society, with input and guidance from engineers and scientists, must determine the target for risk, how much we are willing to spend to achieve the target, and what the most effective use of our resources is in managing the risk we face.

The report states that the risk analysis for the 50-percent and 100-percent cases used the “name plate" capacities for pumps. It goes on to say that these "capacities are considered ideal and do not reflect current or projected actual operational capacities." While we certainly do not disagree, we think this disclaimer needs to be both stronger and more prominent. Unfortunately, this type of analysis runs the risk of lulling the citizens of New Orleans into a false sense of security. Name-plate capacities are based on “new pump” operation at the most efficient point on the head *vs*. volume pump curves. It is not likely that name-plate capacities can be achieved. For example, because of subsidence and higher predicted hurricane tidal surges, all of the lakefront and Industrial Canal pumps must lift drainage water higher than when the pumps were installed. We suspect that during the peak of a hurricane tidal surge many of these pumps may not be able to move any water at all. Future analyses should account for the anticipated performance of individual pumps given the expected range of heads the pumps will encounter to determine their actual capacity under these conditions. We recommend that this discussion be given much more prominence, even to the point of putting a disclaimer on each figure so that it cannot be missed.

We are pleased to see a comprehensive definition of “failure” in Volume VIII: “System failure refers to the failure of the HPS to provide protection from flooding in one or more protected areas, and it can be any failure of one or more components, overtopping of walls or levees, or open gates that prevents the HPS from performing its function.” We recommend emphasizing this definition and moving it to the section, “What is Risk?” on page VIII-2.

The term “risk” means many things to many people. Within both volumes, IPET makes a sincere attempt to put “risk” in perspective. However, there are still several inconsistencies in the use of the terms “risk,” “relative risk,” and “residual risk.” We recommend developing crystal clear and unambiguous definitions for these terms and ensuring that the terms are used consistently throughout the documents.

It would also be helpful to further emphasize the term "residual risk." In this regard, we recommend using a figure similar to Figure 2 (attached), which was developed by the Corps to illustrate how

risk can be reduced and how residual risk can be managed. This figure effectively demonstrates that there are many tools available to contribute to risk reduction and to risk management. In addition to those mentioned, the term levees should be expanded to include other engineered solutions such as channel improvements, subdivided polders, floodwalls, pump stations, and so on. We also recommend that zoning be expanded to include buy-out of flood-prone properties. This figure illustrates that regardless of what is done, there is a residual risk that must be understood, accepted, and then managed. The figure could also be improved by separating the measures that reduce risk from those used to manage the residual risk (for example, outreach and flood insurance).

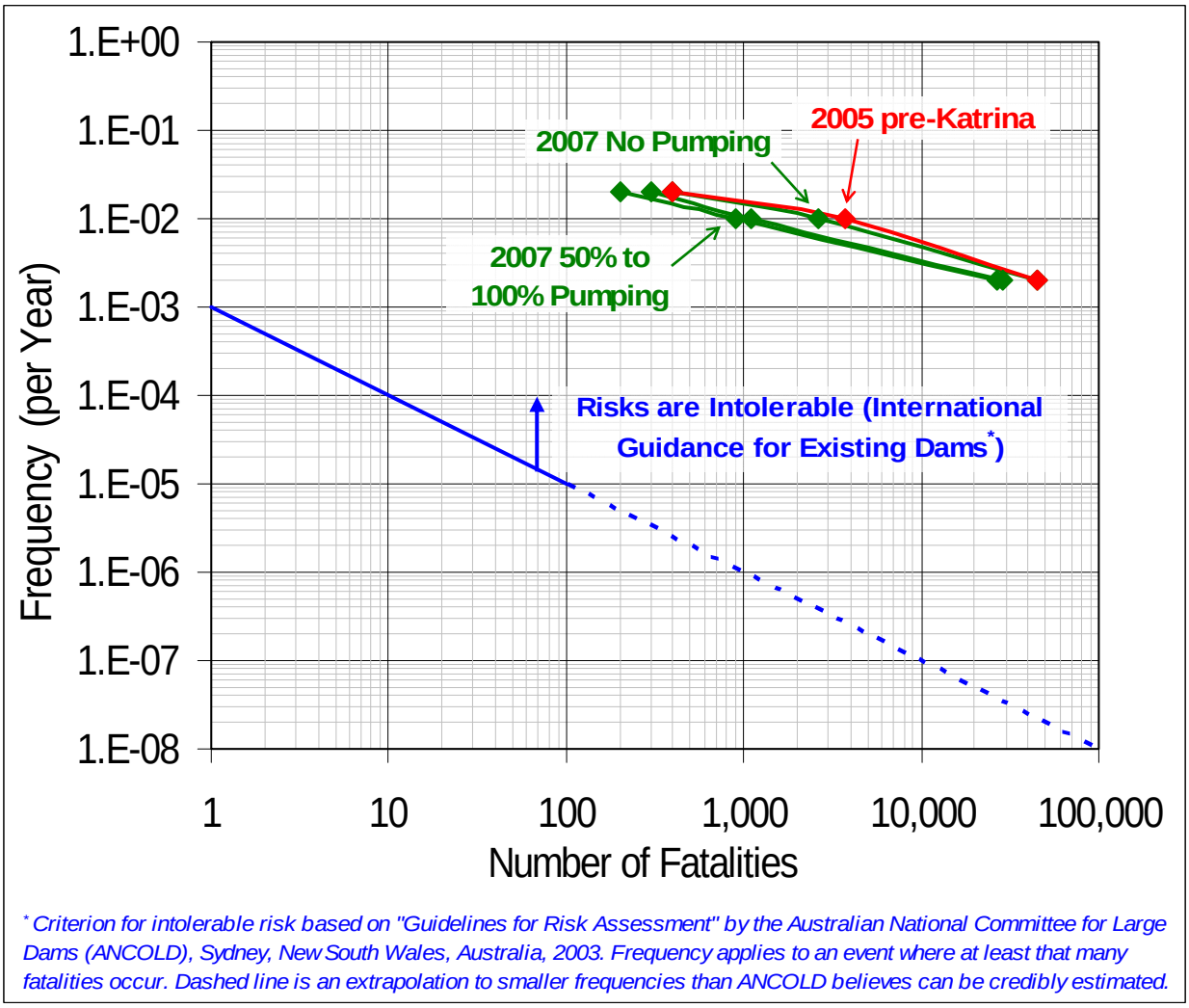
Overall, we believe that the IPET used sound methods of analysis and investigation, and that its conclusions represent logical and appropriate findings from the data collected. In several areas, the IPET's work has advanced the state-of-the-art for analysis of hurricanes and the design of hurricane protection systems. The IPET's report unquestionably presents a great opportunity to improve the planning and design of hurricane protection systems throughout the world, including New Orleans.

We thank you for the opportunity to provide this independent technical review. We wish to express particular appreciation to the IPET lead, Dr. Ed Link, for his many constructive comments and assistance throughout the ERP's review process. If you have any questions, please contact the ERP Chair, Dr. David E. Daniel, at 972.883.2201.

Respectfully submitted,

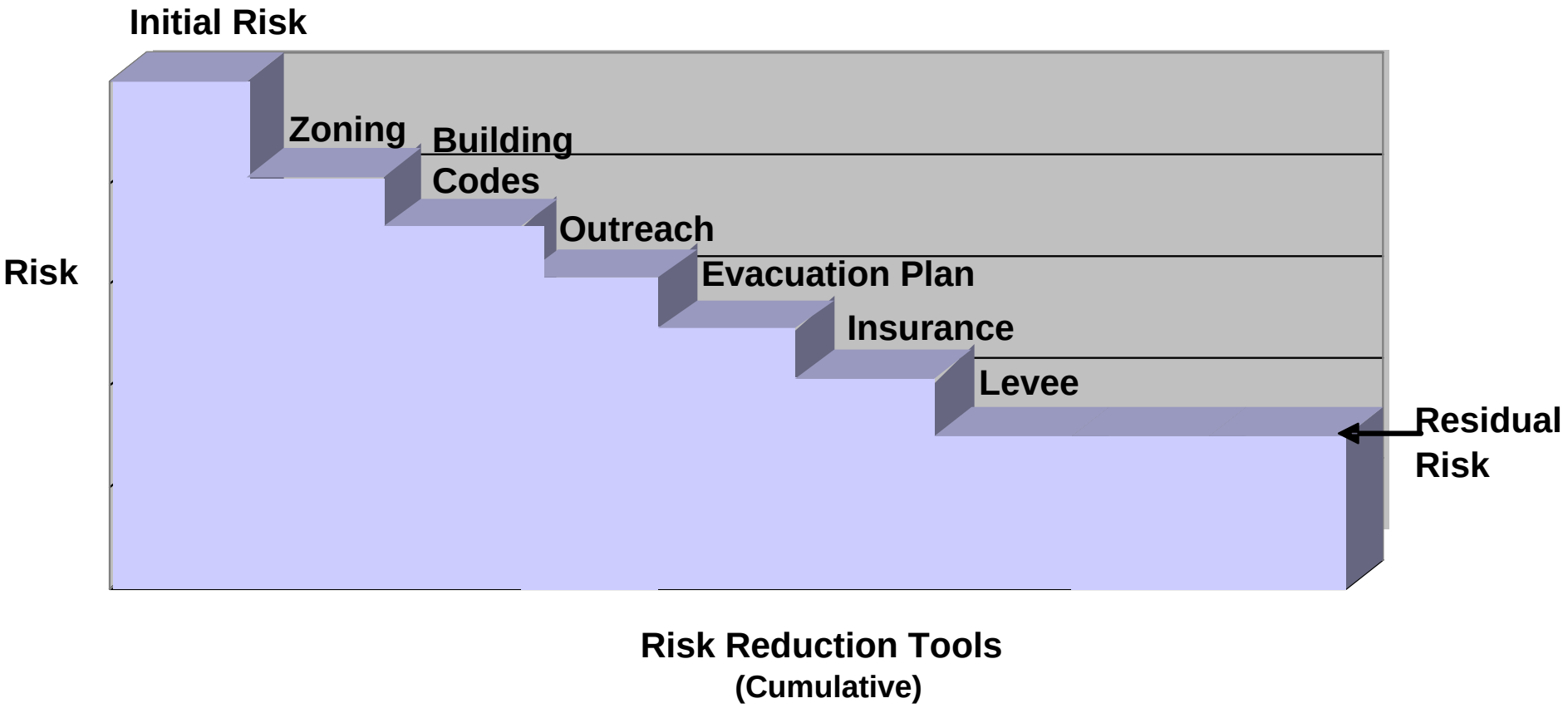
The ASCE External Review Panel

Figure 1 – Graphical Representation of IPET Results



** Criterion for intolerable risk based on "Guidelines for Risk Assessment" by the Australian National Committee for Large Dams (ANCOLD), Sydney, New South Wales, Australia, 2003. Frequency applies to an event where at least that many fatalities occur. Dashed line is an extrapolation to smaller frequencies than ANCOLD believes can be credibly estimated.*

FIGURE 2


Initial Risk
Risk
Zoning
Building Codes
Outreach
Evacuation Plan
Insurance
Levee
Residual Risk
Risk Reduction Tools
(Cumulative)