American Society of Civil Engineers

World Headquarters
1801 Alexander Bell Drive
Reston, VA 21091-4400

(703)295-6000 phone
(703)295-6333 fax
1-800-548-2723 toll free
Web: http://www.asce.org

November 29, 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:

Subject: ASCE's External Review Panel Comments on the Draft Final Report of the Interagency Performance Evaluation Task Force

The External Review Panel (ERP) was convened at your request by the American Society of Civil Engineers (ASCE) to review and evaluate the work of the Interagency Performance Evaluation Task Force (IPET), which is studying the performance of the New Orleans area hurricane and flood protection system during and following Hurricane Katrina. The ERP comprises 14 experts from a range of technical fields and includes private consultants, university professors, and public agency officials. ERP members have expertise in the fields of engineering, the physical sciences, and the social sciences. This letter presents our completed review—with the exception of risk analysis, which is still in process—of the IPET's draft final report, *Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System,* dated June 1, 2006.

In general the ERP believes that IPET's draft final report constitutes an important, technically sound body of work. We are favorably impressed with many aspects of the studies that have been conducted, including the piecing together of information to present a clear picture of the physical events that occurred during and following Hurricane Katrina. We generally concur with the interpretations of the technical data, methods of analysis, and technical findings presented in the draft final report. It is the ERP's opinion that IPET has assembled a conclusive, credible, and comprehensive body of knowledge from which engineering decisions can be made for the near- and long-term evolution of hurricane protection.

We are, however, concerned that the risk assessment task has yet to be completed. The results of this analysis are urgently needed to improve the hurricane and flood protection system, to plan the reconstruction of New Orleans, and to develop long-term strategies for coastal protection and restoration. Currently, the City of New Orleans is proceeding with development without knowledge of what the risks will be in 2007 and beyond.

The ERP believes that it is essential that the Corps place completion of the risk analysis at the highest level of priority. This work is of critical importance, particularly since its findings will affect people's determination as to how safe it is to reside in the New Orleans area.

Furthermore, since the IPET risk analysis is the first step in allowing for fully informed decisions regarding the future of the area, the ERP strongly encourages the Corps to plan carefully how the results will be disseminated and how the analysis will be updated with new information in the future. We recommend that the Corps develop a detailed plan for communicating the results of the completed risk analysis to the public in New Orleans. We recommend that this plan include how to specify and craft the content of the message for understanding by the public, how to disseminate the message through multiple forms of media, and how to promote public participation in the dissemination process. The ERP also recommends that the Corps develop a plan for how the risk analysis, including the data and models, will be maintained and updated in the future. Because the level of risk will change over time—depending on changes in the natural and man-made environments—it is essential that the risk analysis be updated as new information becomes available.

The following is a summary of our review and evaluation of the IPET's draft final report on a volume-by-volume basis.

Volume I Executive Summary and Overview

Overall, the summary document effectively captures the key points presented in the IPET report. We agree with IPET's key findings, which are that:

1. The hurricane and flood protection system was a system in name only.
2. The system lacked redundancy. If a single section of levee failed, an entire area would be flooded.
3. The pump stations, which might have provided some redundancy, did not do so because they were neither designed to operate during a major hurricane nor to survive flooding from a levee breach.
4. Incomplete sections of levee resulted in elevations that were below the intended level of protection.
5. Armoring the levees would have added significant resilience and reduced breaching.
6. Surge gates at the mouths of canals would have provided redundancy.

Based on IPET's documentation and analysis, it is clear to the ERP that the breaching and flooding resulted from multiple, ill-fated choices and decisions that were made at nearly every level. Some of these poor decisions and choices relate to intra- and inter-organizational issues, which are beyond the IPET's scope. But to help understand such issues, more information on the "why" of various choices—that is, the rationale behind key decisions on matters that are discussed in detail in the IPET's report—should be developed. The ERP understands, however, that the Corps is undertaking a comprehensive "decision chronology" evaluation, which should provide insight and understanding "whys."

The ERP agrees with the IPET that the performance was less than the design intent, and agrees with the findings with respect to incomplete protection, construction using erodible materials, and the lack of consideration of the impacts if the design event or system requirements were to be exceeded. However, additional information should be included on why these choices were made.

The ERP believes that the word “marginal” in the statement “The designs for these structures were marginal with respect to practice…” is far too generous in that it minimizes information documented by IPET suggesting that serious design mistakes were made. The ERP believes that some designs were much too close to the margins of safety and that protection of the public safety and welfare was not always the top priority when some choices and decisions were made.

This volume also notes that “there was no evidence of government or contractor negligence or malfeasance.” The ERP believes that the IPET should delete this comment because such judgments are beyond the scope of the IPET’s work.

Volume II Geodetic Vertical and Water Level Datums

Volume II provides a clear articulation of the historical changes to geodetic vertical and water level datums over time in the New Orleans region. There is also a comprehensive evaluation of the use of benchmark elevations in the design and construction of specific projects at London Avenue, Orleans Avenue, the 17th Street Outfall Canal and the Inner Harbor Navigation Canal. The approaches used in establishing elevations at these sites are presumably representative of procedures followed throughout the establishment of the New Orleans Hurricane Protection System since the 1960s.

Volume II provides an impressive explanation of the complex issues associated with elevations relative to levels of hurricane and flood protection in an area subject to changes in water level (tending to rise) and subsidence (lowering elevations on land). The specific review of project documents for those previously identified areas is presented in a straightforward manner and within the context of the data available at the time of design and construction and guidance documents in effect at those times. Clearly there was a lack of adequate concern for and appreciation of the need for reliable and current vertical controls for the design and construction of hurricane protection projects in New Orleans. The need to tie to controls related to water surface elevations, which were the presumed basis of the establishment of levels of protection, was missed.

Subsidence is a well known phenomenon in this region and yet there was apparently no concerted effort to monitor subsidence over time, or to account for the effects of subsidence in the design process. As newer geodetic vertical datum information became available it was not expeditiously incorporated in the New Orleans area. There is no evidence that procedures were in place to re-evaluate the effects of subsidence on previously constructed portions of the hurricane protection system. So, even if the datum had been updated, there was apparently no recognition of the need for re-evaluation of the effects of subsidence on the levels of protection.

The value of the substantial work effort that resulted in this volume will be realized only if there is immediate follow-up implementation of the IPET recommendations. Establishment of formal agreements between the Corps and the National Oceanic and Atmospheric Administration (and other potential partnering organizations) to enable establishment of monitoring programs that can build on the work established by IPET is critical in maintaining reliable geodetic and water level datum information. This effort is necessary to support the establishment and ongoing effectiveness of the hurricane and flood protection system for New Orleans.

Overt consideration of the effects of subsidence in the design process and establishment of ongoing monitoring to recognize the effects of subsidence on the intended level of hurricane protection is also dependent on implementation of the recommendations that will provide a reliable basis for these decisions. Without this level of commitment Volume II of the report constitutes nothing more than a snapshot in time and the mistakes that were made are destined to be repeated.

Volume III   The Hurricane Protection System

Volume III is clearly the result of an extensive effort to provide a factual description of the levees, floodwalls, and interior drainage appurtenances in place in the New Orleans and Vicinity Hurricane Protection System at the time of Hurricane Katrina. However, the exhaustive information presented is a great deal for the reader to digest and is not always clear and consistent. The format of how information is presented varies throughout the volume and the division of subsections in section 3.2 down to the seventh level is difficult to follow. This volume would be improved by incorporating clear and simple diagrams that show subsurface conditions and key facets of the design. More detailed maps and consistent drawings and figures would also be helpful. References to reaches, stations, and other data depend on the reader's familiarity with and specific knowledge of the system. Individual components are thoroughly described, but there is no sense of how the hurricane protection system was intended to function as a system. There are several crossings and penetrations of the hurricane protection system by highways and railroads and other known gaps in the system that are not described in the report.

The standard project hurricane is defined as reasonably characteristic of a storm for a specific location. The standard project hurricane is described, but no rationale for the use of the selected standard project hurricane as the design basis is included in comparison to the probable maximum hurricane.

The ERP feels strongly that the design process was un-conservative and that the factor of safety used in levee design was too low. Specific reasoning on how design factors of safety, shear strengths, and loadings were determined is lacking, and it is not apparent in some cases how critical design review comments at the division level were addressed, or in other cases why review comments were apparently disregarded.

The extensive compilation of information in this volume contrasts sharply with limited findings and lessons learned. Commentary on the appropriateness of the levee and I-wall design process, the use of the standard project hurricane, and specific lessons learned would be most appropriate to include in this volume. However, the comment by the IPET that there were no findings of negligence or malfeasance should not be included since such analysis was not part of the IPET's scope of work. It is nonetheless appropriate for the IPET to state where it found that as-constructed conditions were in agreement with the design documents.

Volume IV The Storm

The work reported in this volume focused on providing objective and credible answers to the questions, what were the storm surge and waves used as the basis for design and how do these compare to the storm surge and waves generated by Hurricane Katrina? Due to the intensity of the storm and the lack of resilient recording systems, the desired spatial and temporal resolution of data was not available for calibration of the storm models. The IPET's report presents the collection of all available water level recordings (there were five in Lake Pontchartrain) and wave recordings. Continuous water level recording was available only at one site. Moreover, all water level data were modified to refer them to a consistent datum, NAVD88 (2004.65). Two wave gages were deployed in Lake Pontchartrain, but only one was recovered with data. During the highest wave conditions, the recording from this gage appeared suspect.

The simulations used an advanced, state-of-the-art interpretation of the wind and pressure fields. The significant improvements of the original winds were based on extensive analysis and re-analysis of the available data from various sources. As the work unfolded it became evident that the timing and magnitude of maximum wave and water levels were significantly affected as the storm made landfall. Only a few stations measuring wind speed were operational throughout the storm so comparisons are few. One of the best comparisons is from Southwest Pass, which was excellent until the maximum winds passed the site, at which time the gage appears to have failed. Other gages tracked relatively well but failed much sooner.

A very thorough analysis has been made of the sparse observational data to establish the time line of events by using eyewitness accounts, digital photographs, and stopped clocks. These data have been scrutinized and assembled so as to reconstruct as closely as possible the times when mean-flow overtopping would have begun or breaches would have occurred as well as the timing of the origin of floodwaters in different basins. The results are important for the calibration and/or verification of numerical drainage models. Unfortunately, some discrepancies between input data could not be resolved. Perhaps additional data may become available in the future, which then may help resolve these issues or at least reduce the level of uncertainty.

The regional hydrodynamics work used state-of-the-art numerical surge (ADCIRC) and wave (WAM, WAVEWATCH) models. The report provides a comparison of the simulated water level maxima from Hurricane Katrina, including both the measured values and the design values. Along much of the south shore of Lake Pontchartrain, the computed, observed, and design levels were within two feet, the computed values typically being the lowest. For example, at the

London Avenue Canal the simulated maximum surge elevation was 9.0 feet NAVD88 (2004.65), while the measured and design levels were 11.4 and 12.0 feet, respectively. This systematic difference is ascribed to wave set-up in the near-shore zone, where intense wave breaking takes place. This narrow zone was not resolved by the grid used in the ADCIRC model simulations. However, this volume presents a striking difference between the design and simulated water level maxima for Plaquemines Parish and St. Bernard Parish; here the difference is from four to six feet.

Offshore wave conditions were calculated with the model WAM applied to the entire Gulf of Mexico, including some comparisons to results of the wave model WAVEWATCH. Both are state-of-the-art models. The results were comparable (which is reassuring)—WAM performing slightly better in the comparison to wave buoy data. The one disturbing factor is the inability to capture the peak significant wave recorded by the buoy 42040.

Nearshore wave conditions have been calculated with the model STWAVE, applied to four sub-domains. At many locations, results from these analyses are in sound agreement with the measured and observed values for wave height and period. Near the 17th Street Canal outfall into Lake Pontchartrain, two gages operated during parts of the storm. The measured maximum wave heights at these locations of 8.4 to 9.4 feet with periods of 6.7 to 7.3 seconds compare reasonably well with the computed values of 8.3 feet with a period of 6.7 seconds at the peak of the storm, approximately two hours later. The major difference between simulated wave characteristics and design values was in the peak wave period in the easterly regions (Lake Borgne, Plaquemines Parish) where the design wave periods were typical for locally generated, short-period waves (peak period of the order of 5 to 6 seconds), whereas the simulations indicate dominance of longer-period swell (peak periods on the order of 15 to 16 seconds) moving between or traveling over the offshore islands. Run-up and overtopping by waves on and over levees increase significantly with wave period, so these differences have important consequences for levee designs in those regions.

The description of the results for the surge and the waves is clear and extensive. This volume constitutes outstanding work and the results provide key inputs for other IPET tasks.

The high-resolution hydrodynamics deals with water levels and motions in the immediate vicinity of and against or over the components of the hurricane protection system. Wave penetration and generation in the 17th Street Canal has been investigated with a physical model and two numerical models. A 1:50 scale model was used for the entrance region. The main advantage of the scale model above available numerical models is the better quantification of the effects of the Hammond Highway Bridge and the debris there on the wave transmission, but for that purpose a few tests of one-dimensional propagation in a flume would have been adequate. Moreover, the actual degree of blocking is unknown, so the scale model can serve only to indicate sensitivity in this respect rather than provide an objective quantification. Wave penetration and generation in the 17th Street Canal has also been simulated with two two-dimensional numerical models, the phase-resolving Boussinesq model COULWAVE and the phase-averaged model STWAVE. The former cannot simulate wave generation by wind, in contrast to STWAVE. In the total effort the added value of COULWAVE for this application is very limited. It yields output of unnecessary detail in space and time at the expense of tremendous amounts of CPU-time. Both models simulate losses at the Hammond Highway Bridge on the basis of the physical model results. However, the values reported for the wave heights in the canal near the breach site are internally inconsistent.

Boussinesq simulations are presented for wave motion on and over the levee along the Mississippi River Gulf Outlet, aimed at estimation of particle velocities and overtopping rates. Insights have been obtained with respect to the different particle velocities on the exposed face and the lee side face, as well as the effect of wave direction of approach (normal or oblique incidence). Estimates of total overtopping rates (integrated along the length of the levee) have also been made.

Volume V   The Performance of the Levees and Floodwalls

The main body of Volume V is generally clear and understandable to the non-geotechnical specialist, but is sufficiently detailed so that those knowledgeable in the field can assess the main assumptions, analysis methods, findings, conclusions, and other technical issues. The detailed background information, supporting data, and analyses are included in several appendices to this volume. The ERP has previously provided many specific comments to the IPET on details of the work, interim reports, and the draft final report that relate to the levee and floodwall performance and failures. These comments address details of such matters as presentation of soil strength information, levee erosion, designs and current safety of distressed but un-breached levees and floodwalls, and the generalization of specific findings to the safety of the hurricane protection system as a whole. The ERP encourages the IPET to consider them in preparation of its final report.

The methods used for the limit stability and probability of failure analyses, numerical soil-structure interaction analyses, and physical modeling (centrifuge tests) of the canal levee and floodwall systems are consistent with recent advances in geotechnical practice and current state of knowledge in the field. That the results obtained by these three approaches—each carried out by a different group—are consistent with each other and lead to similar conclusions about failure mechanisms in virtually every case provides strong evidence for the validity of the findings and lessons learned.

Some issues have not been and may never be fully resolved—for example, the two-foot differential in water level at which the failure of the floodwall along the 17th Street Canal would occur according to the calculations and the level at which it did occur according to best estimates from observations. Nonetheless, there is consensus on the overriding importance of the water-filled gap, un-conservative shear strength values used for design at the 17th Street Canal, and low factors of safety that played major causative roles in the failures.

In addition to providing rational explanations for the floodwall failures and levee erosion and breaches caused by Katrina, the findings provide a sound basis for at least partial assessment of the post-Katrina stability of those sections of the levees and floodwalls that did not fail, for aiding Task Force Guardian in the repair and strengthening of the failed sections, and as a starting point for the development of a more resilient hurricane protection system in the future.

In summary this volume presents the results of an in-depth, careful, and credible body of work. Tenable explanations of how the levee and floodwall failures occurred have been developed. However, many questions of the “why” nature remain, as they were considered by the IPET to be beyond the scope of its investigation.

Volume VI The Performance of Interior Drainage and Pumping

The central objective of the work presented in this volume was to determine the answers to the questions, how did the floodwalls, levees, pump stations, and drainage canals—individually and acting as an integrated system—perform in response to Hurricane Katrina, and why? And what was the contribution of the pump stations and drainage system in the unwatering of flooded areas? Additionally, the work addresses the questions, what have been the societal-related consequences caused by Katrina? And what would the consequences have been if the system had not suffered catastrophic failure?

In an effort to answer these questions the IPET team developed both hydrologic (HEC-HMS) and hydraulic models (HEC-RAS) of the polders. New capabilities were added to the HEC-RAS model to simulate the drainage system and changing levee heights (repair work between the two hurricanes). The models incorporated the work of the other teams, integrating data describing the geometric basin, rainfall, hydraulic boundary conditions, levee failures, and pump station operations. The models were verified using measured water depth observations. Following the verification, various “what if” scenarios were run through the model for each polder and are included in the appendices for this volume. These scenarios included the baseline Katrina model runs and those with no levee failure and operational pumps stations.

The ERP is satisfied with the hydraulic and hydrologic models that were developed and believes that the IPET’s interior drainage team met its objectives. While the unwatering was not specifically addressed in the modeling, the model scenarios provide insight into the process. The team’s work provided appropriate input for the consequences volume.

The main criticism of the interior drainage portion was the limitations of the analysis and results with respect to the polder-specific lessons learned and the value and future applications of the hydraulic and hydrologic models. The models developed during the IPET investigation show how the interior drainage system responded to Hurricane Katrina and provide insight into how to improve the hurricane protection system. It is critical that these models be maintained and used in conjunction with the risk models to further protect New Orleans. We expect this issue to be addressed in the IPET’s final report.

The pump stations should be an integral part of the hurricane protection system. Prior to Katrina, however, the pump stations were all built and owned by various entities within each parish and the Corps has not had any responsibility for the operation or construction of new pump stations. The Corps has participated only in the design and construction of floodwalls related to the pump stations.

As an integral part of the hurricane protection system the pump stations must be built and maintained to uniform standards. There are very large variations in pump station design, construction, and maintenance among the five parishes in the New Orleans metropolitan area. For the most part the pump stations in Orleans Parish are older well-built stations using horizontal Wood Screw pumps driven by 25 Hz electric motors. The major problem with these stations is the inability to pump against a 12- to 15-foot surge.

Jefferson Parish has replaced most of its pump stations within the past 10 to 15 years. The new stations are modern and are designed to remain in service during storm events. On the other hand, pump stations in St. Bernard, Plaquemines, and St. Charles parishes are a mix of both old and new facilities, only some of which can operate during hurricane conditions.

During a storm event, the pump stations must remain operational to remove rainwater from the polder during storms (most hurricane and tropical storms also include very heavy rainfall, which often exceeds the 10-year design storm rainfall); prevent backflow through the pumps from the flood side to the protected side; remove floodwater from levee overtopping; and remove water from levee or floodwall breaches. A number of functions were evaluated during the IPET's investigation, including the pump stations' ability to: prevent surge from entering the protected side of the basin either via backflow through an inoperable or un-operated pump, or overtopping of the floodwall or levee at the station; sustain operations during an extended storm event with sufficient fuel storage on-site for diesel driven pumps and diesel driven generators; provide backup generation for electric pumps and ancillary pump station equipment—including such things as vacuum pumps, compressors, station lighting, motor control panels, and communication; maintain stability of the station structure to withstand winds in excess of 150 miles per hour; provide operator protection inside the station structure during severe storms, which include remote controls and visual and audible monitors for remote operation during the peak of the storm; remove debris from the bar screens during the peak of the storm—including trash rack cleaners and conveyor belts—without endangering operators; protect all equipment vital to the pump operation by elevating the operating floor slab and the equipment above the expected surge; and provide backup systems for vital infrastructure.

There must be consistency in the ability of these pump stations to operate for extended periods under extreme weather conditions as well as to provide adequate surge protection during a hurricane. There should also be consideration of transferring responsibility of the external drainage pump stations (pump stations discharging into a tidal waterway) to the two new levee boards for the Pontchartrain and Barataria basins to maintain consistency of design, construction, operation, and maintenance.

Volume VII The Consequences

The text of this volume presents data, analyses, and conclusions regarding economic, life safety, environmental, and historical and cultural consequences of the Hurricane Katrina-induced levee failures in New Orleans. The ERP has offered a number of specific comments on this and previous report drafts. These comments will not be repeated here; instead, this review offers broad summarizing comments.

Sound data and appropriate analyses are reported on direct economic consequences. Much less data were reported and analyzed regarding indirect economic consequences since much of the data were not available when the IPET conducted its work, and no data were reported and analyzed regarding indirect economic consequences that were still occurring when the work was performed and on those consequences that likely continue. Despite these gaps this volume clearly provides available data, explains how it was analyzed, and reaches credible conclusions.

If further work were to be performed (particularly on indirect economic consequences) it would be important (if it is, indeed, possible) to distinguish between economic consequences that are the result of the levee failures versus those that are the result of policy and program responses to the levee failures—for example, indirect economic consequences that resulted from government (local, state, and federal), private sector, and citizen responses and non-responses.

The IPET collected data on life and safety consequences from available sources. These data are clearly presented and analyzed in the draft final report. Unfortunately, data on death and morbidity were not available for perhaps as many as one-third of the missing persons, who most likely lost their lives. Consequently, although the data presented for death and morbidity are probably accurate for the cases that were examined, many other cases had to be excluded from the presented data. These cases could dramatically alter some of the conclusions that are reported—for example, the gender and racial profiles of those who lost their lives and other conclusions.

Additionally, the general picture regarding the life and safety consequences of the levee failures from Hurricane Katrina remains incomplete, largely because the data needed to complete this picture were not available at the time the work was performed or because it was beyond the scope of the IPET's work. Some of these gaps are well recognized and were clearly reviewed in the draft final report. For example, likely mental health consequences are reviewed even though mental health data were not available. Other gaps remain; for example, the health and safety consequences of the levee-induced mass evacuation/migration of victims into host populations.

The data and the assessment that the IPET presents on environmental consequences are appropriately completed. Unfortunately, there are many aspects of environmental consequences that are not reported or examined in the draft final report.

A complete assessment of historical and cultural consequences would include data and analyses on a set of varied and diverse topics. This section of the volume does recognize some of the diversity of data types and topics that would need to be covered to address the topic, but it provides little actual data regarding the vast majority of possible Katrina-related historical and cultural consequences. The data presented are largely limited to the number of schools and hospitals open before and after the levee failures. Most of the topics that could be examined are not examined, and most of the data that would be collected and analyzed in the course of a more thorough analysis are missing. The result is that we do not have anything approaching a reasonable understanding of the historical and cultural consequences of the levee failures induced by Hurricane Katrina.

In summary, the ERP finds the data and analyses presented in this volume of the draft final report to be credible and shed some light on the human and societal consequences of the levee failures in New Orleans. On the basis of the data and analyses that are presented, more is known about some consequence categories than others. However, many questions about consequences remain unanswered, and data relating to them have yet to be collected. The IPET's scope of work on consequences was limited to using secondary data that were collected by others, and to the shorter- rather than longer-term time frame of the consequences assessment.

Volume VIII Engineering and Operational Risk and Reliability Analyses

At this time the risk and reliability analysis has not been completed and we are able to comment only on the proposed methodology that is presented in this volume. The overall methodology is sound and defensible. We commend the IPET for the tremendous effort that was put forth to obtain, compile, and catalog a detailed physical description of the entire hurricane protection system in its current condition. This information will be valuable not only for this risk analysis but for future analyses and planning purposes. We also commend the IPET for engaging the Federal Emergency Management Agency and the National Oceanic and Atmospheric Administration in modeling and predicting the storm surge hazard. This cooperation will be particularly helpful in producing consistent and defensible information for decision makers and stakeholders.

When the results are presented, we expect the IPET to include information about validation and calibration for the following models: storm surge, rainfall, interior drainage, and floodwall and levee reliability. We also expect an accounting of the significant uncertainty associated with all of these models due to the relative sparseness of data that exists to validate and calibrate them (that is, the epistemic uncertainty). And because the level of risk will change over time—depending on fluctuations in the natural and man-made environments—it is essential that the risk analysis be updated as new information becomes available. Only then can fully informed decisions be made regarding the future of the region.

Concluding Remarks

The ERP extends its appreciation to the Corps of Engineers for seeking this review of the IPET's work and for the constructive and professional manner in which it engaged the ERP. From the outset the IPET maintained a good working relationship with the ERP. We appreciate the professional manner in which interactions have occurred. The overall review process was one in which we met with the IPET every six to eight weeks. Between these formal meetings, we engaged in detailed technical dialogues concerning the work and we offered our feedback and suggestions. For example, we held separate meetings with the IPET to discuss the geotechnical findings related to the breaches at the 17th Street and London Avenue Canals. More recently we have also held several meetings regarding the risk analysis work. Finally, the IPET co-leaders were informally paired with ERP members, and over the course of our review there was regular communication by both telephone and e-mail. We appreciate the fact that the IPET listened carefully to our feedback and recommendations and incorporated key suggestions into its work. We have not identified any IPET finding that we believe contains a major technical flaw.

It took considerable courage for the Corps to call for detailed external peer review for a project with such high visibility. The Corps should be commended for this action. We wish to congratulate and thank Corps and IPET leadership—in particular you, Don Basham, Ed Link, and John Jaeger—for establishing a sound technical framework as well as an atmosphere of collegiality and cooperation for our review as you undertook, and successfully accomplished, this enormous performance evaluation. The nation owes a debt of gratitude to the dedicated efforts of the more than 150 engineers and scientists who labored so long and hard to provide meaningful input into rebuilding the New Orleans and Southeast Louisiana hurricane protection system. It was indeed an honor for each of us to be associated with such a comprehensive evaluation and analysis leading to useful findings and critical lessons learned.

ASCE and the ERP thank you for the opportunity to be of service to the Corps and to the nation.

Sincerely,

The ASCE External Review Panel

Christine F. Andersen, P.E., M.ASCE
Jurjen A. Battjes, Ph.D.
David E. Daniel, Ph.D., P.E., M.ASCE, Chair
Billy L. Edge, Ph.D., P.E., F.ASCE
William H. Espey, Jr., Ph.D., P.E., M.ASCE
Robert B. Gilbert, Ph.D., P.E., M.ASCE
Thomas L. Jackson, P.E., F.ASCE
David N. Kennedy, P.E., M.ASCE
Dennis S. Mileti, Ph.D.
James K. Mitchell, Sc.D., P.E., Hon.M.ASCE
Peter G. Nicholson, Ph.D., P.E., F.ASCE
Clifford A. Pugh, P.E., M.ASCE
George J. Tamaro, P.E., Hon.M.ASCE
Robert G. Traver, Ph.D., P.E., M.ASCE