National Institute of BUILDING SCIENCES™

Panel Decision and Report

SRP FLPBC013123

Palm Beach County, FL

January 4, 2024

Innovative Solutions for the Built Environment

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List of Abbreviations

ADCIRC	Advanced Circulation (model)
BFE	Base Flood Elevation
CFR	Code of Federal Regulations
ECCFL	East Coast Central Florida
ESL	Elemental Slope Limiter
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
HWM	High Water Mark
IDS	Intermediate Data Submission
JPM	Joint Probability Method
JPM-OS	Joint Probability Method – Optimal Sampling
LiDAR	Light Detection and Ranging
LOMR	Letter of Map Revision
NAVD88	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
NIBS	National Institute of Building Sciences
NOAA	National Oceanic and Atmospheric Administration
OWI	Ocean Weather Inc.
PBC	Palm Beach County

PFD	Primary Frontal Dune
SFL	South Florida
SFLSSS	South Florida Storm Surge Study
SRP	Scientific Resolution Panel
SWAN	Simulating Waves Nearshore
SWEL	Still Water Elevation
WHAFIS	Wave Height Analysis for Flood Insurance Studies
QA/QC	Quality Assurance / Quality Control

Summary

Based on the submitted scientific and technical information, and within the limitations of the Scientific Resolution Panel (SRP), the Panel has determined that two separate decisions are necessary to address the original appeal filed by Palm Beach County in July 2021. With respect to the use of outdated topographic elevation data, the Panel finds that portions of the Community's data satisfy NFIP standards and correct or negate FEMA's data on the basis of changed physical condition. These issues appear to have been resolved by way of FEMA's issuance of updated FIRM panels described in its January 2023 appeal resolution document. The Panel is satisfied with the resolution of this issue raised by the Appellant and believes no further action is necessary.

With respect to the remaining technical issues raised by Palm Beach County in their July 2021 appeal, the Panel has determined that the Community's data does not satisfy NFIP standards, thus FEMA's data is not corrected, contradicted, or negated. Based on the information provided, the Panel cannot identify specific scientific, technical, or mathematical errors that have contributed to flawed Flood Insurance Rate Maps. The Panel is similarly unable to identify deviations from established mapping standards and guidelines that would contribute to erroneous base flood elevations. The Panel's decision is largely based upon the incomplete appeal submission provided by Palm Beach County in their July 2021 submission.

1.0 Introduction

This report serves as the recommendation to the Federal Emergency Management Agency (FEMA) Administrator from the National Institute of Building Sciences (NIBS) Palm Beach County, FL Scientific Resolution Panel (SRP). SRPs are independent panels of experts organized, administered, and managed by NIBS for the purpose of reviewing and resolving conflicting scientific and technical data submitted by a community challenging FEMA's proposed flood elevation. SRPs are charged with helping to efficiently resolve appeal and protest issues between FEMA and communities by acting as an independent third party in an effort to obtain the best data possible for the community's Flood Insurance Rate Maps (FIRMs).

2.0 Panel

Panel ID: FLPBC013123

Panel Name: Palm Beach County, FL

FEMA Region: IV

Panel Members:

- Bret Webb, PhD, PE, BC.CE, University of South Alabama, Mobile, AL is a Professor of Coastal Engineering in the Department of Civil, Coastal, and Environmental Engineering at the University of South Alabama. Dr. Webb received his BS in Civil Engineering, his MS in Coastal & Ocean Engineering, and his PhD in Coastal & Ocean Engineering all from the University of Florida prior to joining the faculty of the University of South Alabama. Dr. Webb has more than 20 years of experience as a coastal engineer including considerable time in both consulting and academia. Dr. Webb is a licensed professional engineer (AL, FL) and is recognized by the Academy of Coast, Ocean, Port, and Navigation Engineers as a Board-Certified Coastal Engineer. Dr. Webb's area of research and professional practice deals with coastal resilience. Within that broad topic, he focuses on resilience of the built environment to extreme events and climate change and on the resilience benefits provided by natural and nature-based features. Dr. Webb has authored more than 50 peer-reviewed publications and has given close to 100 technical presentations on coastal resilience topics.
- Francis Way, PE, CFM, Applied Technology & Management, Charleston, SC is a Senior Coastal Engineer in ATM's Charleston, SC office with more than 23 years professional experience in coastal, environmental, and water resources engineering. He specializes in coastal and water resources analyses and permitting, modeling, beach nourishment, dredging and navigation studies, and shoreline stabilization projects. He performs hydrodynamic, water quality, flushing, watershed, sediment, and wave modeling. Mr. Way has performed dozens of FEMA remapping efforts, including LOMRs, CLOMRs, seawalls, VE zone fill studies, and appeals. Mr. Way has also provided expert witness testimony related to FEMA flood zone mapping and has performed flood zone mapping for Caribbean islands using FEMA methodology. Mr. Way earned a MS in Ocean Engineering from Texas A&M University in 2000 and a BS from Boston College in 1993. He is licensed as a professional engineer in South Carolina and North Carolina as well as a Certified Floodplain Manager (CFM).
- John Lally, PE, Lally Consulting, LLC, Seattle, WA has over 30 years of experience in coastal engineering and construction throughout the United States and Canada, South America, Asia, Africa, and the Caribbean. With a career coupled as consulting engineer and marine contractor, in 2008, Mr. Lally founded Lally Consulting LLC, an engineering and environmental consulting firm

that specializes in the design and implementation of coastal engineering, waterway restoration, and dredging projects. Mr. Lally has performed site physical and processes analyses, oceanographic data collection, hydrographic surveys, engineer-diver surveys, numerical modeling, engineering design, evaluation of alternative construction methods, contract plans and specifications preparation, permitting and environmental compliance monitoring, project management and construction oversight for a broad range of coastal, waterway, and environmental projects. Mr. Lally has a BS in Ocean/Coastal Engineering from Florida Institute of Technology and advanced graduate work in the Master of Offshore and Dredging Engineering Program at Technical University Delft. He is a licensed professional engineer in Washington and Louisiana.

- Shih-Ang (S. A.) Hsu, PhD, CCM, Professor (Emeritus) of Marine Meteorology and Air-Sea Interaction, Coastal Studies Institute, Louisiana State University, Baton Rouge, LA earned his PhD in Meteorology in 1969, from the Atmospheric Sciences Group in the Department of Civil and Environmental Engineering at the University of Texas at Austin. In 1988, Dr. Hsu published the textbook "Coastal Meteorology '' by the Academic Press. Dr. Hsu also has published over 250 articles related to coastal and marine meteorology, air-sea interaction, and engineering meteorology in the refereed journals and chapters of several encyclopedias, including a chapter entitled "Air-Sea-Land Interactions during Tropical Cyclones" in the Encyclopedia of Water by Wiley in 2019. Since 1979, Dr. Hsu has earned his "Certified Consulting Meteorologist" (CCM) certificate as certified by the American Meteorological Society.

- Siavash Hoomehr, PhD, PE, CFM - Area market Sector Lead with HDR, in the NYC, NY metropolitan area. Dr. Hoomehr has over 17 years of combined experience in project management and water resources engineering analysis and design. He is responsible for the entire life cycle of projects, including client relationship, proposal development and review, project management of multidisciplinary teams, project controls, and technical delivery. He has managed various projects for clients ranging from federal, state, and local government to individual property owners, including USACE, FEMA, and NJDEP. He also has extensive experience in watershed assessment, development of flood protection alternatives, design and modeling of flood control projects; stormwater management and drainage design, advanced hydrologic and hydraulic modeling in support of USACE flood control projects and FEMA flood studies; dam break analysis, inundation mapping and Emergency Action Plan (EAP); levee superiority and interior drainage analysis; bridge scour analysis; and sediment transport modeling.

3.0 Basis for Appeal

Palm Beach County contends that all 52 Preliminary FIRM panels published by FEMA on December 20, 2021, covering Palm Beach County, are scientifically and technically incorrect. The Appellant lists the primary error as the wind and atmospheric pressure grids used in the model study. Specifically, the Appellant believes the grids are too coarse, and the subsequent model results are inaccurate. The Appellant also identifies and outlines a number of other potential modeling deficiencies in their July 2021 appeal. Specifically, the documentation outlines their arguments for scientific and/or technical deficiencies associated with the 1) wind and pressure field grid resolution; 2) model setup inconsistencies; and 3) incorrect application or treatment of model uncertainties. The Appellant also points to more recent topographic elevation data (released during the mapping process) that should have been used to map the flood hazard areas. Finally, the Appellant describes two additional items that may impact base flood elevations: treatment of tidal data and the validation storms selected for the mapping study.

The Panel has chosen to organize their response around the following eight discrete issues identified (by the panelists) in the Appellant's documents:

1. Topographic Elevation Updates
2. Meteorological Forcing Resolution
3. Model Setup Inconsistencies
4. Model Uncertainty Application
5. Treatment of Tidal Data
6. Model Validation and Validation Storms
7. Primary Frontal Dune Updates
8. Historical Record Context

Subsequent sections of this report that summarize decisions made by the Panel and its rationale are similarly organized into these eight discrete issues. Note that the enumeration of these issues does not imply importance or significance, nor does it match any numbering scheme used in materials provided by the Community or FEMA.

4.0 Data Submitted by the Community and FEMA

The following subsections of the report list materials, reports, relevant communications, and data submitted by the Appellant and FEMA and/or their technical mapping partners. The panelists were instructed to only consider materials submitted by the Appellant and received by FEMA, during the appeal period of 4/16/21 - 7/15/21. Though some information contained in the list of materials submitted by the Appellants fall outside of this window, panelists did not base their decision on materials that were proffered outside of the appeal period.

4.1. APPELLANT

The Appellant provided a number of documents, some of which originated from FEMA as part of the appeal process, and digital files associated with ADCIRC input and output for three specific synthetic storms. These files were made available to the panelists through the SRP portal. A list of the documents provided by the Appellant is provided below:

- 4-16-2021_FL_PalmBeachCo_Comment Resolution_app.pdf: This letter from Kristen M. Martinenza (FEMA Region IV) to Doug Wise (Floodplain Administrator, Palm Beach Co) dated April 16, 2021, briefly describes with dates and time periods, delays and postponements of the appeal and comment periods. The letter indicates that the original 90-day appeal and comment period, which should have commenced on or around February 4, 2020, was postponed to April 16, 2021 … 16 months after issuance of the preliminary flood insurance rate maps and flood insurance study for Palm Beach Co. The 90-day appeal period window was thus 4/16/21 - 7/15/21, as mentioned in the preamble to this section.
- PBC_to_FEMA_FIRM_appeal_09Jul2021.pdf: This 68-page document contains the official appeal request letter issued by Verdenia C. Baker (County Administrator, Palm Beach Co) as well as a report that serves as the technical basis and justification for the appeal. The report covers the scope of the appeal; the basis for appeal; a discussion regarding areas of scientific and/or technical deficiency; a section describing changed physical conditions and the availability of more recent topographic elevation data; and concerns regarding treatment of tidal data and the validation storms. The report also identifies five appendices labeled Appendix A to Appendix E that provide additional information and documentation.
- PBC_to_FEMA_FIRM_appeal_appendices_09Jul2021.pdf: This 290-page document contains items submitted as Appendix A to Appendix E mentioned previously. Those appendices are labeled as follows:
    - Appendix A - Mesh and Nodal Attributes Applied in Final Storm Run
    - Appendix B - Topographic Elevation Data Technical Memorandum
    - Appendix C - Data and Documents Review Technical Memorandum
    - Appendix D - Storm Surge, Wave Model & Flood Map Evaluation

    - Appendix E - Relevant Correspondence from Palm Beach County to FEMA
- PalmBeachCo_TaylorEmail.pdf: This document contains the bodies of two separate emails between Jeremy McBryan (County Water Resources Manager, Palm Beach Co) and Michael Taylor (AECOM). The originating email sent by Jeremy McBryan dated July 14, 2021, at 6:03 PM, formally appeals the Preliminary Flood Insurance Rate Maps and Flood Insurance study for Palm Beach Co and contains three separate links to data and documents. The response from Michael Taylor dated July 15, 2021, at 9:15 AM, acknowledges receipt of the appeal and links to supporting data and documents.
- PBC SRP_Appeal Resolution Letter_01032023.pdf: This letter from Kristen M. Martinenza (FEMA Region IV) to Verdenia C. Baker (Palm Beach Co) dated January 3, 2023, consists of a formal response to and resolution of Palm Beach County's official appeal request of submitted data on July 9, 2021. The letter response categorizes issues into two main groups: topographic data and South Florida Storm Surge Study inputs and methods. The letter briefly outlines the FEMA process for incorporating the newer topographic elevation data and the subsequent changes to 21 FIRM panels. The letter also provides responses to the Appellant's concerns regarding wind and pressure field resolution; model setup and stability issues; model uncertainty; treatment of tidal data; application of validation storms; and some other related technical issues.
- PBC_Letter_Requesting_FEMA_SRP_2023.02.01.pdf: This letter from Paul F. Linton (Water Resources Manager, Palm Beach Co) to Kristen M. Martinenza (FEMA Region IV) dated February 1, 2023, formally requests a Scientific Resolution Panel to help adjudicate their appeal and concerns raised in July 2021. This document contains some new figures and an appendix that represents new information not provided during the official appeal period. These materials were identified by FEMA and AECOM, and panelists were asked not to consider this information in their deliberations. This document does contain other relevant and applicable information, such as the Scientific Resolution Panel Request Form (Appendix A) and a list of documents previously submitted as part of the original July 2021 appeal (Topographic Elevation Data Technical Memorandum; Data and Documents Review Technical Memorandum; and Storm Surge, Wave Model and Flood Map Evaluation).
- storm-18-rerun folder: This folder contains the model parameters input file (fort.15) for ADCIRC along with the maximum water surface elevation output (maxele.63) for synthetic storm #18 and a "readme" file explaining the files and directory structures …
    - fort.15
    - maxele.63_storm18
    - maxele.63_storm18c
    - readme.txt
- storm-20-rerun folder: This folder contains the model parameters input file (fort.15) for ADCIRC along with the maximum water surface elevation output (maxele.63) for synthetic storm #20 and a "readme" file explaining the files and directory structures …

  - fort.15
  - maxele.63_storm20
  - maxele.63_storm20c
  - readme.txt
- storm-21-rerun folder: This folder contains the model parameters input file (fort.15) for ADCIRC along with the maximum water surface elevation output (maxele.63) for synthetic storm #21 and a "readme" file explaining the files and directory structures…
  - fort.15
  - maxele.63_storm21
  - maxele.63_storm21c
  - readme.txt

4.2. FEMA

FEMA and/or its technical mapping partners (Taylor Engineering [storm surge modeling]; Michael Baker [statistics]; AECOM [coastal transects]; and Gabe del Toro [expert review]) provided approximately 7 TB of submittals that were transmitted to panelists on individual external hard drives (one for each panelist). The external drive contains three primary folders and within each folder a number of subfolders and/or files. The contents of the drive are too numerous to list individually, so the files are simply summarized below:

- Intermediate Data Submittals 1-3: These IDS submittals address such items as the technical approach for the South Florida Surge Study; selection of validation storms; description of coastal features and site characteristics; basic parameter ranges for the JPM-OS technique; winds from OceanWeather Inc.; the topobathymetric digital elevation model; descriptions of the circulation and wave models; wave and circulation model validation results; final information about the JPM-OS methodology; supporting information about the production model runs; an analysis of the low frequency water levels (i.e., 2-, 1-, and 0.2-percent-annual-chance still water elevations); and an analysis of high frequency water levels using tide gauges (i.e., 4-, 10-, 20-, and 50-percent-annual-chance events).
- Intermediate Data Submittals 4-5: These submittal files contained correspondence associated with the IDS reviews; the FIS data, graphics, and reports; spatial analysis files; stillwater analysis data; and transect-based wave hazard analysis files (i.e., WHAFIS information).
- Preliminary Flood Insurance Rate Map (FIRM) Panels: Fifty-two unique FIRM panels were submitted covering the study area.
- South Florida Surge Study: This folder contained a number of subfolders consisting mostly of data files to support the mapping study, such as the final digital elevation model data; JPM data to support the modeling; model mesh files; production run inputs/outputs; the starting wave conditions for transect-based wave hazard modeling (WHAFIS modeling); statistical analysis of low and high frequency water levels; and validation data.

- Email from Adam Clinch (AECOM) to Lauren Schmied (FEMA) dated October 26, 2023, 5:04 PM, with the subject "Palm Beach County SRP Request Document (2/1/23) contains new data": This email identifies some materials submitted by the Appellant after the appeals period.
- Email from Tahir Benabdi (FEMA) to Mira Papinova (NIBS) dated October 31, 2023, 11:00 AM, with the subject "FW: FLPBC013123 SRP - Oral Presentations Dates": This email and series of embedded emails in a threaded conversation outline concerns regarding materials submitted by the Appellant outside of the appeals period.

5.0 Summary of Panel Procedures

5.1. PANEL MEETINGS

The SRP Panel virtually met four times to discuss the appeal. The Panel first met on October 12, 2023. The purpose of the first meeting was to select a Panel Chair (Dr. Bret Webb), address data accessibility issues, generally discuss the materials and technical areas of the appeal, and to determine our timeline for future meetings. The Panel then met for a second time on October 23, 2023. The discussion in this meeting was heavily focused on the technical aspects of the appeal and on the materials submitted by both Palm Beach County and the FEMA team. During this meeting, we assigned roles and responsibilities whereby each panelist would be in charge of responding to an issue (or more than one issue) raised in the appeal by Palm Beach County. The Panel met again for a third time on November 30, 2023, to discuss the five possible explanations for accepting or denying the appeal by Palm Beach County. The Panel was able to eliminate some of those explanations, leaving only two possible explanations. The Panel then briefly discussed the next steps and a timeline for completion of the Panel report. The Panel met a fourth time on December 15, 2023, to discuss elements of the Panel report and to confirm the Panel's findings on various aspects of the appeal.

5.2. COMMUNITY MEETING

The SRP panelists virtually attended the community meeting held on November 20, 2023. During that meeting, panelists listened to oral presentations first by the Appellant (Palm Beach County) and second by FEMA and their contracting team. Panelists then had an opportunity to direct questions to both Palm Beach County and to the mapping team.

5.3. REPORT DEVELOPMENT

Development of the draft final report commenced on December 4, 2023. A draft final report was transmitted to NIBS on or around December 21, 2023.

6.0 Decision

Based on the submitted scientific and technical information and within the limitations of the Scientific Resolution Panel (SRP), the Panel determined that two separate decisions are necessary to address the original appeal filed by Palm Beach County in July 2021. With respect to the use of outdated topographic elevation data, the Panel finds that portions of the Community's data satisfy NFIP standards and correct or negate FEMA's data on the basis of changed physical condition. With respect to the remaining technical issues raised by the Appellant in their July 2021 appeal, the Panel has determined that the Community's data does not satisfy NFIP standards, thus FEMA's data is not corrected, contradicted, or negated. Based on the information provided, the Panel cannot identify specific scientific, technical, or mathematical errors that have contributed to flawed, inaccurate, or incorrect Flood Insurance Rate Maps. The Panel is similarly unable to identify deviations from established mapping standards and guidelines that would contribute to erroneous base flood elevations and mapping products.

6.1. TOPOGRAPHIC ELEVATION UPDATES

Portions of the Community's data satisfy NFIP standards and correct or negate FEMA's data.

The Panel is satisfied with the outcome for this item. The Panel does agree with the Appellant that updating the WHAFIS model transects based on the updated topography would be ideal, however there are no known FEMA guidelines that require this. FEMA does have guidance in place to use the most accurate existing topography data, as noted below.

6.2. METEOROLOGICAL FORCING RESOLUTION

The Panel finds that the Community's data does not satisfy NFIP standards, thus FEMA's data is not corrected, contradicted, or negated.

The Panel finds that the Appellant has not satisfactorily demonstrated that the use of regional scale wind and pressure field grids would produce substantially more accurate base flood elevations. There are three specific reasons that support the Panel's rationale. First, the Appellant demonstrates in their appeal documents that they are unable to directly reproduce FEMA's results when using the exact same model version and files. Second, the presentation of the results leaves many unanswered questions. Third, the inconsistency of the model behavior across the three storm scenarios raises serious concerns about the model setup and application.

6.3. MODEL SETUP INCONSISTENCIES

The Panel finds that the Community's data does not satisfy NFIP standards, thus FEMA's data is not corrected, contradicted, or negated.

The Appellant has not produced any data, results, or maps that can be used to refute the Preliminary Flood Insurance Rate Maps and Flood Insurance Study. Whether any of the concerns raised by the Appellant rise to the level of a scientific or a technical deficiency is impossible to evaluate for three reasons. First, the inability of the Appellant to reproduce FEMA's results using the same model version and input files calls into question any and all model results submitted by the Appellant. Second, the vast discrepancy (order of magnitude) between water level differences produced by the Appellant and by FEMA calls into question the veracity of the Appellant's model implementation. Third, the lack of any completed mapping products makes it impossible to determine whether (or not) altering any of the methodologies or practices outlined previously would have a measurable impact on the final base flood elevations in Palm Beach County.

6.4. MODEL UNCERTAINTY APPLICATION

The Panel finds that the Community's data does not satisfy NFIP standards, thus FEMA's data is not corrected, contradicted, or negated.

The SRP Panel agrees with FEMA with regard to using the LOMR process for submission, review, and evaluation of relevant input data/parameters and exploring sensitivity of model results to each input parameter. A duplicate effective model is required as a baseline for evaluating the concerns raised by Appellant vs. FEMA model results.

6.5. TREATMENT OF TIDAL DATA

The Panel finds that the Community's data does not satisfy NFIP standards, thus FEMA's data is not corrected, contradicted, or negated.

The Appellant raised important questions regarding the treatment of tidal data in the SFLSSS model, however updated analysis and mapping is ultimately required for submittal. With respect to the 3-month tide data selection question, review of several years of predicted tidal data for the study area by the Panel determined there is not significant variance (<0.1 ft.) in predicted tides across sample years that would create uncertainty in the model. The Panel sees the 3-month period selected by FEMA, August – October, coinciding with hurricane season in the project area, as reasonable, as well as its 30-day spin-up to provide sufficient tidal forcing ahead of the synthetic storm runs. Further, the Panel recognizes coupled SWAN and ADCIRC models of the SFLSSS region can be started both "cold," with natural spin-up, or hot-started, which may be preferable, or required, to accommodate large models with many scenarios to run. The Panel agrees with FEMA's approach.

6.6. MODEL VALIDATION AND VALIDATION STORMS

The Panel finds that the Community's data does not satisfy NFIP standards, thus FEMA's data is not corrected, contradicted, or negated.

The Appellant raised a valid consideration, and the Panel agrees that inclusion of historical hurricanes Frances and/or Jeanne in the validation storm suite could make the SFLSSS model more accurate, particularly in the northern area of the model domain. However, given the SFLSSS is a regional study, the Panel agrees with FEMA's approach and storm selection criteria and finds the validation storm suite it assembled to be reasonable and consistent with common practice. Ultimately, the Appellant did not provide evidence by way of analysis and mapping that changes in validation storms would affect SWEL or resulting BFEs in Palm Beach County.

6.7. PRIMARY FRONTAL DUNE UPDATES

The Panel finds that the Community's data does not satisfy NFIP standards, thus FEMA's data is not corrected, contradicted, or negated.

The Appellant has valid questions regarding FEMA mapping with regard to dune removal and PFD location, however updated analysis and mapping is ultimately required for submittal. The Appellant is correct that the 1:50 slope is standard; however, FEMA mappers do have flexibility based on historical eroded profiles. The Panel agrees with FEMA's approach.

6.8. HISTORICAL RECORD CONTEXT

The Panel finds that the Community's data does not satisfy NFIP standards, thus FEMA's data is not corrected, contradicted, or negated.

The presence of a historical record that does not contain maximum water surface elevations that are as high or higher than base flood elevations does not constitute grounds for an argument that the Preliminary Flood Insurance Rate Maps or the Flood Insurance Study are scientifically or technically incorrect or deficient. The historical record of water levels in areas of the U.S., where coastal hazards are dominated by tropical cyclones, has little to do with actual flood hazard vulnerability.

7.0 Rationale for Findings

In all but one area of the Community's appeal (outdated topographical elevations and changed physical condition), the Panel's overarching decision is that the Community's data does not satisfy NFIP standards, thus FEMA's data is not corrected, contradicted, or negated. Though the Panel provides detailed summaries, statements, and rationale for each of the Appellant's concerns raised in their appeal dated July 2021, and also in the SRP request letter dated February 2023, their ultimate decision was influenced by the lack of information provided. The Panel recognizes the time and effort required for an Appellant to prepare the required documentation; however, the lack of final mapping products, or at least nearly equivalent mapping products, makes it impossible for the Panel to assess the importance, significance, or merit of concerns raised by the Appellant.

Before addressing each of the eight topics outlined previously, the Panel wishes to document its understanding of the appeals process and the documentation required as part of an appeal and/or SRP. Below is a summary of the Panel's assessment or characterization of Palm Beach County's materials as constituting an incomplete appeal submittal.

FEMA: The Appellants are required to demonstrate that the alternative methods or applications result in more correct estimates of flood hazard determinations. The Appellant's July 2021 submission did not demonstrate more correct estimates of flood hazard determinations. FEMA's 1/3/2023 Appeal Resolution letter stated: "PBC submittal does not provide a detailed examination of how these aspects related to model skill or uncertainty would significantly affect the SFLSSS water level versus frequency curves or the base flood elevations developed, nor is there a proposed 'more correct' solution."

The Panel also received an email from FEMA on 12/7/2023 regarding this topic:

"As noted by PBC, the standard in the law states that the scope of the appeal requires an appellant to establish that FEMA's determination or designation was "scientifically or technically incorrect." This could include a math error or demonstration that a principle or method used during the study was not scientifically sound. The use of the language "more correct" is tied to FEMA regulations, specifically 44 CFR 67.6 Basis of appeal and expands the breadth of appeals beyond purely identification of an error to allow for new, more detailed analysis that could be deemed "more correct." The applicable language from the CFR is provided below for reference. This and the FEMA Guidance for Flood Risk Analysis and Mapping: Appeal and Comment Processing are the most applicable documents for use in the review of appeal-period submittals.

The materials submitted by Palm Beach County do not establish that FEMA has made an outright error – the methodology followed by the study team during the FIS meets or exceeds FEMA guidance and standards as stated in the appeal resolution letter dated 1/2/2023. It has withstood internal and external

review by experts within the field and meets or exceeds the standard of care implemented on similar studies, nationally as stated in that same January letter.

Enclosure A of the 1/2/2023 appeal resolution provides a detailed response from FEMA as to the concerns with the PBC submittal including issues with the wind and pressure field grid, the model setup, the model uncertainty, as well as other items detailed in the letter. Importantly, as discussed during the SRP presentation, Enclosure A details how FEMA's analysis using the data provided by Palm Beach County shows that Palm Beach County's plots greatly overestimate the effect of the wind grid setup and also the Palm Beach County versus FEMA model simulations. FEMA encourages the use of the LOMR process to further refine these issues in order to resubmit data for review when it is ready.

44 CFR 67.6 Basis of Appeal.

(a) The sole basis of appeal under this part shall be the possession of knowledge or information indicating that the elevations proposed by FEMA are scientifically or technically incorrect. Because scientific and technical correctness is often a matter of degree rather than absolute (except where mathematical or measurement error or changed physical conditions can be demonstrated), appellants are required to demonstrate that alternative methods or applications result in more correct estimates of base flood elevations, thus demonstrating that FEMA's estimates are incorrect.

(b) Data requirements.

(1) If an appellant believes the proposed base flood elevations are technically incorrect due to a mathematical or measurement error or changed physical conditions, then the specific source of the error must be identified. Supporting data must be furnished to FEMA, including certifications by a registered professional engineer or licensed land surveyor, of the new data necessary for FEMA to conduct a reanalysis.

(2) If an appellant believes that the proposed base flood elevations are technically incorrect due to error in application of hydrologic, hydraulic or other methods or use of inferior data in applying such methods, the appeal must demonstrate technical incorrectness by:

(i) Identifying the purported error in the application or the inferior data.

(ii) Supporting why the application is incorrect or data is inferior.

(iii) Providing an application of the same basic methods utilized by FEMA but with the changes itemized.

(iv) Providing background technical support for the changes indicating why the appellant's application should be accepted as more correct.

(v) Providing certification of correctness of any alternate data utilized or measurements made (such as topographic information) by a registered professional engineer or licensed land surveyor, and

(vi) Providing documentation of all locations where the appellant's base flood elevations are different from FEMA's.

(3) If any appellant believes the proposed base flood elevations are scientifically incorrect, the appeal must demonstrate scientific incorrectness by:

(i) Identifying the methods, or assumptions purported to be scientifically incorrect.

(ii) Supporting why the methods, or assumptions are scientifically incorrect.

(iii) Providing an alternative analysis utilizing methods, or assumptions purported to be correct.

(iv) Providing technical support indicating why the appellant's methods should be accepted as more correct and

(v) Providing documentation of all locations where the appellant's base flood elevations are different from FEMA's.

APPELLANT: The Appellant maintained that performing the entire storm surge mapping and rezoning effort was not possible given the limited 90-day appeal period.

PBC also provided the following in its presentation (slide 4):

- Per 44 CFR 67.6 and the FEMA Guidance for Flood Risk Analysis and Mapping: Appeal and Comment Processing (Feb 2019), the sole basis of an appeal is the possession of knowledge or information indicating that the flood hazard determinations proposed by FEMA are scientifically or technically incorrect.
- The appellants are required to demonstrate that the alternative methods or applications result in more correct estimates of flood hazard determinations.

PBC also provided the Biggert-Waters Flood Insurance Reform Act of 2012 and asserted in an email provided to the Panel on 12/1/2023 that:

"The law (Public Law 112-141 Section 100217 Scope of Appeals subsection (B)) requires that the appellant demonstrates that "special flood hazard areas are scientifically or technically incorrect." The law has no specific requirement that the appellant regenerate all of the FIRMs. Public Law 112-141 July 6, 2012 Section 100217 Scope of Appeals subsection (B) states that, "The sole grounds for appeal shall be the possession of knowledge or information indicating that (1) the elevation being proposed by the Administrator with respect to an identified area having special flood hazard are scientifically or technically incorrect, or (2) designation of an identified special flood hazard area is scientifically or technically incorrect.""

FINDING: The Biggert Waters Act of 2012 was one of several acts to update FEMA regulations. There was also the Homeowner Flood Insurance Affordability Act of 2014 which "repealed certain parts of previous law – Biggert-Waters" (source: https://www.fema.gov/flood-insurance/rules-legislation/laws).

Overall, there are several laws and regulations that govern the NFIP (see list in the above link), including the CFR (Code of Federal Regulations). In reviewing all applicable laws and regulations, the CFR appears to be the most specific and relevant and is commonly cited in FEMA documents (including the 2019 FEMA appeal and comment submittal guidance document).

On the CFR website, it states: "The Code of Federal Regulations (CFR) is the official legal print publication containing the codification of the general and permanent rules published in the Federal Register by the departments and agencies of the Federal Government."

While the February 2019 FEMA guidelines on appeal and comment submittals only recommend certification and updated flood maps (and use more vague wording like "should include," the CFR is much clearer that the Appellant needs to submit certified maps/analyses documenting new base flood elevations.

CFR with excerpts highlighted pertaining to appeal submittals:

§ 67.6 Basis of appeal

(a) The sole basis of appeal under this part shall be the possession of knowledge or information indicating that the elevations proposed by FEMA are scientifically or technically incorrect. Because scientific and technical correctness is often a matter of degree rather than absolute (except where mathematical or measurement error or changed physical conditions can be demonstrated), ***appellants are required to demonstrate that alternative methods or applications result in more correct estimates of base flood elevations***, thus demonstrating that FEMA's estimates are incorrect.

(b) Data requirements.

(1) If an appellant believes the proposed base flood elevations are technically incorrect due to a mathematical or measurement error or changed physical conditions, then the specific source of the error must be identified. Supporting data must be furnished to FEMA ***including certifications by a registered professional engineer or licensed land surveyor,*** of the new data necessary for FEMA to conduct a reanalysis.

(2) If an appellant believes that the proposed base flood elevations are technically incorrect due to error in application of hydrologic, hydraulic or other methods or use of inferior data in applying such methods, the appeal must demonstrate technical incorrectness by:

44 CFR 67.6(b)(2)

(i) Identifying the purported error in the application or the inferior data.

(ii) Supporting why the application is incorrect or data is inferior.

(iii) Providing an application of the same basic methods utilized by FEMA but with the changes itemized.

(iv) Providing background technical support for the changes indicating why the appellant's application should be accepted as more correct.

(v) Providing certification of correctness of any alternate data utilized or measurements made (such as topographic information) by a registered professional engineer or licensed land surveyor, and

(vi) Providing documentation of all locations where the appellant's base flood elevations are different from FEMA's.

(3) If any appellant believes the proposed base flood elevations are scientifically incorrect, the appeal must demonstrate scientific incorrectness by:

(i) Identifying the methods, or assumptions purported to be scientifically incorrect.

(ii) Supporting why the methods, or assumptions are scientifically incorrect.

(iii) Providing an alternative analysis utilizing methods, or assumptions purported to be correct.

(iv) Providing technical support indicating why the appellant's methods should be accepted as more correct and

(v) Providing documentation of all locations where the appellant's base flood elevations are different from FEMA's.

The PBC submittal did not include any updated maps showing base flood elevations (BFEs). In typical appeal submittals, a stamped work map and annotated FIRM panels are required. Neither of these items was included in the PBC submittal.

The Panel agrees with FEMA that this submittal is incomplete. While the Panel generally agrees that re-performing an entire surge study and updating study area BFEs is not practical in the 90-day appeal period timespan, the CFR is clear that updated BFEs are required for an appeal submittal.

7.1. TOPOGRAPHIC ELEVATION UPDATES

The Appellant provided more up-to-date LiDAR for several panels of the preliminary maps.

FEMA: FEMA made flood zone adjustments to accommodate the updated special flood hazard area (SFHA) extents based on the data provided, but no overland modeling adjustments were made based on this data. Nine (9) preliminary FIRM panels were updated based on updated topographic data.

APPELLANT: Appellant was satisfied with the updated panels based on the submitted LiDAR data. In their presentation (slide 24), they state: "PBC is satisfied with this response – PBC would have preferred to update the overland flooding but concur that the results would likely have been minor and localized."

FINDING: The Panel is satisfied with the outcome for this item. The Panel does agree with the Appellant that updating the WHAFIS model transects based on the updated topography would be ideal; however, there are no known FEMA guidelines that require this. FEMA does have guidance in place to use the most accurate existing topography data, as noted below.

SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
43	5/31/2015	Implemented for all projects that have not yet begun data development	Elevation Data	Working Standard	All updated flood hazard data shown on the FIRM, in the FIRM Database and FIS must be based on the most accurate existing topographic data available to FEMA before the start of data development and the data must have documentation that it meets the following vertical accuracy requirements: [Vertical Accuracy Requirements based on Flood Risk and Terrain Slope within the Floodplain being Mapped] [table] *Fundamental Vertical Accuracy (FVA) and NVA are reported at the 95% Confidence Level. **Consolidated Vertical Accuracy (CVA) and VVA are reported at the 95th Percentile. If data is not available that meets these requirements, new elevation data must be obtained (Refer to Figure 1 in Appendix C)

Figure 1: FEMA SID 43. (SID=Standard Identification Number). Source: https://www.fema.gov/sites/default/files/documents/fema_policy-standards-flood-risk-analysis-mapping-rev-13.pdf

7.2. METEOROLOGICAL FORCING RESOLUTION

The Appellant raises concerns regarding the lack of resolution in the wind and pressure field grids over the entirety of Palm Beach County. The Appellant believes that use of the OWI basin scale wind and pressure field grids over the northern 32 miles of Palm Beach County produce incorrect water surface elevations in the ADCIRC simulations. The Appellant believes that the OWI regional scale wind and pressure field grid should be extended to cover all of the mapping area for Palm Beach County.

APPELLANT: In its July 2021 appeal, Palm Beach County expresses concern over the use of coarser (15 n.mi. by 15 n.mi.), basin scale wind and pressure field grids for the northern 32 miles of the County. The Appellant contends that the lack of resolution in the meteorological forcing leads to erroneous still water elevations in the study area. They assert that the finer resolution (3 n.mi. by 3 n.mi.), regional scale grid covering the southernmost 12 miles of Palm Beach County and the remainder of South Florida should be

applied over the entire mapping area. The Appellants support their concerns with graphical output from the simulations of three synthetic storms (#18, #20, #21). A series of figures (Figures 9-14) show the differences in simulated maximum water surface elevation output from ADCIRC for two different modeling scenarios: 1) the original mapping configuration using both the regional and basin scale wind and pressure fields; and 2) an alternative model setup where only the basin scale wind and pressure fields are used. The figures show differences in maximum water surface elevations at discrete points within and outside of the mapping area. The Appellants note differences of up to 8 feet in their results.

FEMA: In their appeal resolution letter dated January 2023, the FEMA team directly addresses the wind and pressure field grid resolution concerns raised by Palm Beach County. Since a regional wind and pressure field grid does not exist for all of the mapping study, the FEMA team recreated the simulations described in the Appellant's July 2021 submittal. Specifically, the FEMA team simulated storms #18, #20, and #21 without the regional meteorological data in an attempt to reproduce the Appellant's results. While the appellant noted maximum water surface elevation differences as high as 8 feet in some cases, FEMA's differences only varied from -0.5 ft to +0.3 ft across all three storm scenarios. FEMA notes in its response that the Appellant's inability to directly reproduce FEMA's results using the exact same model version, setup, and inputs (see page 36 of 62 of the Appellant's July 2021 submittal) makes it difficult to evaluate the modeling results shown in the appeal.

FINDING: The Panel finds that the Appellant has not satisfactorily demonstrated that the use of regional scale wind and pressure field grids would produce substantially more accurate base flood elevations. There are three specific reasons that support the Panel's rationale. First, and perhaps most importantly, the Appellant demonstrates in their appeal documents that they are unable to directly reproduce FEMA's results when using the exact same model version and files. This calls into question all of the subsequent modeling that the Appellant performed and provided as justification for their concerns and assertions that the mapping study contains scientific and/or technical errors. Second, even if the veracity of the Appellant's modeling results were not in question, the presentation of the results in Figures 9-14 leaves many unanswered questions. For example, why are the differences shown only as discrete points? What is the significance of the points shown? Why weren't differences shown as spatially-varying fields across all mesh nodes/elements? Were these truly "physical" differences in the event response, or were these differences attributed to model instabilities at discrete nodes? Third, the inconsistency of the model behavior across the three storm scenarios raises serious concerns about the model setup and application. For example, in Figures 9-10 (storm #18), the largest differences and the highest concentration of points shown are within an area of the model grid where nothing changed. More specifically, these points fall within the basin scale meteorological grid, and this area remained unchanged between the two model setups. Furthermore, differences shown (e.g., Figure 10) in the regional grid coverage are comparatively much smaller by an order of magnitude. The Appellant's argument that improving the meteorological forcing resolution would lead to substantially different results is completely negated by their own results shown in Figure 10. The results provided in Figures 11-14 further complicate issues because 1) there are very

few results shown in Palm Beach County for storm #20; and 2) the behavior in the magnitude, distribution, and density of differences is inconsistent between storms #18 and #21.

7.3. MODEL SETUP INCONSISTENCIES

The Appellant raises a number of potential concerns regarding model setup and implementation inconsistencies in their original July 2021 appeal package.

APPELLANT: In its July 2021 appeal, Palm Beach County raises a number of concerns related to model setup and/or implementation. The concerns are numerous and only briefly summarized in the list below:

- Restricting localized water level gradient: The Appellant raises concerns about use of the elemental slope limiter (ESL) nodal attribute in the fort.13 input to ADCIRC, as well as the number of different (8 in total) ESL nodal attribute datasets that were used in the mapping study.
- Canal filled mesh: The Appellant notes that some canals less than 120 ft in width were artificially filled and their elevations set to +3 ft NAVD88 (at or below bank elevation) to address model instabilities. No specific concerns or deficiencies were otherwise noted.
- Disabled wind stress forcing in Broward County: The Appellant notes that wind stress forcing was disabled in some overland locations outside of Palm Beach County to address model instabilities, but did not note any specific concerns or deficiencies.
- Deepening of the Caribbean bathymetry: The Appellant notes that some areas of the mesh were altered by artificially lowering the nodal elevations to address model instabilities far from the study area, but did not note any specific concerns or deficiencies.
- Identifying instabilities: The Appellant argues that the FEMA classification of simulations as stable or unstable (based on surge recession) is vague and points to the ADCIRC NFOVER parameter value as a "… tool(s) to identify potential numerical instabilities …" The Appellant raises no specific concerns or deficiencies related to the final mapping products.
- Lack of quality assurance and quality control at the local level: The Appellant raises concerns about the lack of local change/sensitivity analyses performed when making changes to the model setup/implementation (see many of the points raised previously). For example, the Appellant points to the assessment of regional changes in water surface elevations when filling canals in portions of Palm Beach County.
- Importance of consistent model setups in producing reliable results: The Appellants raise concerns regarding the number of different model mesh and nodal attributes files used in the production runs. The Appellant argues that a single mesh and nodal attribute file should be used for all production runs. The Appellant does not provide any information to suggest that use of 24 different mesh and nodal attribute files has resulted in scientifically or technically deficient base flood elevations.
- Local numerical instabilities at PBC inlets: The Appellant raises concerns about the mesh resolution, mesh representation, and model results at Boynton Inlet. The Appellant argues that the

lack of resolution within the inlet presents appropriate hydraulic conveyance during the storm event, resulting in artificially high water surface elevations within Lake Worth Lagoon. The Appellant provides a figure (Figure 19) showing the change in water surface elevations along the inlet centerline when the mesh resolution is doubled.

- Assignment of nodal attributes: The Appellant raises concerns about the assignment of Manning's n roughness values, the chosen values, and where there may be deviations from expected values. No assessment or sensitivity analyses were performed or provided to identify potential impacts of the roughness values on base flood elevations.
- Re-simulated storm results with FEMA inputs does not match FEMA's original results: The Appellant attempted to reproduce FEMA's original maximum water surface elevation results for storms #18, #20, and #21 but were unable to do so. Differences between the Appellant's results and FEMA's values are as large as 9 feet in some locations. Though the Appellant states that the same model version and model inputs were used, they were unable to reproduce FEMA's original simulation results for those three storm scenarios.
- Model run for tide effects: The Appellant raises concerns about the methodology used to prepare the tidal forcing hot start files for the synthetic storm simulations. Instead of running the tidal forcing simulation for three continuous months, a number of shorter simulations were performed and intervening hot start files were used as input to subsequent simulations. The Appellant is concerned that such a practice will lead to errors that propagate through all subsequent simulations. The Appellant also raises concern over the assignment of ADCIRC run time parameter values, particularly when the process results in irrational values (i.e,. RNDAY = 79.66666…). The Appellant claims that this can create problems in ADCIRC.

FEMA: The appeal resolution letter submitted by FEMA in January 2023 addresses each of the above concerns with a reasonable and brief response. Those responses are briefly paraphrased below for the sake of brevity:

- Restricting localized water level gradients: Use of the elemental slope limiter feature in ADCIRC is a reasonable way to damp local instabilities and has been used in other mapping studies.
- Canal filled mesh: This is a reasonable approach to addressing local instabilities, and small-scale canals are not required for developing countywide FIS data.
- Disabled wind stress forcing: Technical deficiencies associated with this practice were not identified during the QA/QC process, and a sensitivity analysis for the approach was documented in Appendix B of IDS 3, Section 1.
- Deepening of the Caribbean bathymetry: Technical deficiencies associated with this practice were not identified during the QA/QC process, and this approach has been successfully applied in other mapping studies.
- Identifying instabilities: FEMA better describes its process for identifying instabilities using contour plots of maximum and minimum water surface elevations that were automatically generated for

reviewers. This same methodology has been applied consistently in at least four other mapping studies to date.

- QA/QC at the local level: FEMA argues that local changes are expected due to the nature and necessity of the mesh revisions and that the regional checks are more important for the scale of the mapping study performed. FEMA notes that additional QA/QC is performed in a detailed fashion as part of the review process and is described further in IDS 3, Section 4. Any remaining instabilities are addressed during the transect-based wave hazard modeling.
- Consistent model setups: FEMA notes that use of unique model mesh and node attributes is common practice in storm surge studies and is consistent with procedures used in at least four other mapping studies. Some of the mesh and nodal attribute updates required to address local instabilities were very small and would not require re-running production simulations with the updated files.
- Local instabilities at Boynton Inlet: FEMA notes that QA/QC of maximum water levels produced in the vicinity of Boynton Inlet did not yield spatial gradients and that the drawdown within the inlet shown by the appellant may not be representative of the remaining 391 storm events for that area.
- Assignment of nodal attributes: FEMA states that the accuracy of the nodal attribute values is reasonable given the scale of the regional grid.
- Re-simulated storm results: The FEMA team attempted to reproduce these large differences in water surface elevations noted by the appellant. Using the values provided by the Appellant, the FEMA team was only able to produce differences on the order of 0.5 feet or less across Palm Beach County, whereas some of the Appellant's difference plots show values as large as 8 or 9 feet. FEMA notes the inability of the appellant's model implementation to reproduce FEMA's data for the three selected synthetic storms.
- Model run for tide effects: FEMA's response notes that no errors in the tidal validation runs were evident during the QA/QC process and that the same methodology was used in two other completed mapping studies.

FINDING: While the Panel believes that more consistency in model setup and implementation is something all mapping studies should strive for, the Appellant has not produced any data, results, or maps that can be used to refute the Preliminary Flood Insurance Rate Maps and Flood Insurance Study. Whether any of the concerns raised by the Appellant rise to the level of a scientific or a technical deficiency is impossible to evaluate for three reasons. First, the inability of the Appellant to reproduce FEMA's results using the same model version and input files calls into question any and all model results submitted by the Appellant. Second, the vast discrepancy (order of magnitude) between water level differences produced by the Appellant and by FEMA calls into question the veracity of the Appellant's model implementation. The order of magnitude difference cannot simply be explained by computational platforms or compiler flags. Third, the lack of any completed mapping products makes it impossible to determine whether (or not) altering any of the methodologies or practices outlined previously would have a measurable impact

on the final base flood elevations in Palm Beach County. Because of the number of steps involved in between generating the ADCIRC output and deriving the flood hazard areas and elevations, it is impossible to know whether any of the issues above would yield more accurate FIRM panels.

7.4. MODEL UNCERTAINTY APPLICATION

The Appellant questioned the application of model uncertainty in their original appeal submission dated July 2021.

APPELLANT (July 9, 2021): Model uncertainty, applied in post-processing results, is based in part on a study-specific Model Validation Error, calculated as the standard deviation of the differences between simulated and measured water surface elevations at observation points used in the model validation analysis for Hurricanes Andrew, Betsy, David, Georges, and Wilma (244 observation points throughout FEMA's SFL Study area). Three different issues related to how model uncertainty was computed were identified and are as follows:

1. The Model Validation Error is applied uniformly across the SFL Study area, despite the model validation appearing to be spatially variable. That is, higher model validation (less error) is presented for Palm Beach County in the northern portion of the SFL Study area.

2. Two types of water level data are considered within the model validation: 1) hydrograph data from gauge measurements, and 2) highwater marks (HWM) from post-storm survey measurements. The different sources are treated the same, even though it is acknowledged that HWMs are less reliable.

3. Storm surge is generally greatest along a storm's track. As the distance from a storm's track increases or as the storm tracks away from a particular location, storm surge decreases and changes in water levels become increasingly governed by astronomical tides. While it is acknowledged that FEMA's extensive model validation resulted in reasonable agreement with measured astronomical tides, less favorable agreement with measured water levels during the modeled validation storms suggests that the coastal processes associated with storm surge may not be sufficiently represented by the SWAN+ADCIRC model developed by FEMA.

FEMA (January 3, 2023): The PBC submittal provides information related to the SFLSSS uncertainty analyses and alternative ways to calculate the model performance (uncertainty, skill, bias) based on different decisions or regions. The SFLSSS methods to develop and apply uncertainty estimates followed similar procedures to other recent east coast Florida FEMA storm surge studies where a regional, study-wide, estimate of uncertainty was developed and applied. This is consistent with application in other studies as cited, as well as a correct application per FEMA Guidance for Flood Risk Analysis and Mapping: Statistical Simulation Methods (2016). The uncertainty approach and results underwent quality control checks by the internal technical team, the Coastal Advisory Panel, and an independent team developed by

FEMA including FEMA staff and independent consultants. In addition, throughout Section 4.3, the PBC submittal does not provide a detailed examination of how these aspects related to model skill or uncertainty would significantly affect the SFLSSS water level versus frequency curves or the base flood elevations developed, nor is there a proposed "more correct" solution.

FEMA (Email Dec. 7, 2023): Enclosure A of the 1/2/2023 appeal resolution provides a detailed response from FEMA as to the concerns with the PBC submittal including issues with the wind and pressure field grid, the model setup, the model uncertainty, as well as other items detailed in the letter. Importantly, as discussed during the SRP presentation, Enclosure A details how FEMAs analysis using the data provided by Palm Beach County shows that Palm Beach County's plots greatly overestimate the effect of the wind grid setup and also the Palm Beach County versus FEMA model simulations. FEMA encourages the use of the LOMR process to further refine these issues in order to resubmit data for review when it is ready.

APPELLANT: Appellant was not satisfied with the FEMA responses before and during the SRP period.

FINDING: The SRP Panel agrees with FEMA in regard to using the LOMR process for submission, review, and evaluation of relevant input data/parameters and exploring sensitivity of model results to each input parameter. A duplicate effective model is required as a baseline for evaluating the concerns raised by appellant vs FEMA model results.

7.5. TREATMENT OF TIDAL DATA

The Appellant has two concerns regarding treatment of tidal data in the SFLSSS model; 1) they question FEMA's 3-month tide data selected to simulate tidal variation in the project area, and 2) they disagree with FEMA's use of the hot-start method to combine tidal runs.

FEMA: In FEMA's appeal response (1/3/2023) regarding the tide data selection, their review of the data found the 3-month tide period to reasonably capture the tidal variation in the project area. FEMA also indicated the tidal validation runs using the hot-start function were reviewed as part of the QA/QC process and errors were not identified based on the methodology applied. FEMA elaborated on this point in their oral presentation (11/20/2023), stating that the FEMA study automated the setup of tide run control files through shell scripting, and the FEMA review does not find this setup more prone to error than the appellant-suggested alternative of exporting tide phase parameters individually for each storm.

APPELLANT: In their letter request for ISRP (1/30/2023) the Appellant maintains their concern for the model run for tide effects and 3-month tide data selection, but did not elaborate further on these concerns during their oral presentation, acknowledging these were likely lower contributors to BFE.

FINDING: The Appellant raised important questions regarding the treatment of tidal data in the SFLSSS model, however updated analysis and mapping is ultimately required for submittal. With respect to the 3-month tide data selection question, review of several years of predicted tidal data for the study area by the

Panel determined there is not significant variance (<0.1 ft.) in predicted tides across sample years that would create uncertainty in the model. The Panel sees the 3-month period selected by FEMA, August – October, coinciding with hurricane season in the project area, as a reasonable, as well as its 30-day spin-up to provide sufficient tidal forcing ahead of the synthetic storm runs. Further the Panel recognizes coupled SWAN and ADCIRC models of the SFLSSS region can be started both "cold", with natural spin-up, or hot-started, which may be preferable, or required, to accommodate large models with many scenarios to run. The Panel agrees with FEMA's approach.

7.6. MODEL VALIDATION AND VALIDATION STORMS

The SFLSSS coupled SWAN+ADCIRC model was validated using five (5) historical hurricanes: Betsy (1965), David (1979), Andrew (1992), Georges (1998), and Wilma (2005). The Appellant has identified two others, Hurricanes Frances and Jeanne (2004), as potentially more suitable validation storms for FEMA to consider.

FEMA: In their appeal response (1/3/2023), FEMA points out that hurricanes Frances and Jeanne (2004), both used in the storm suite to validate the ECCFL model, made landfall north of Palm Beach County, with the highest storm surge, waves and resulting erosion in Martin, St. Lucie, Indian River, Brevard and Volusia Counties. FEMA states in their appeal response, the appellant submittal did not demonstrate that changes to storm validation would affect SWEL or resulting BFEs in Palm Beach County.

FEMA elaborated on their methodology used to select validation storms for the SFLSSS in their oral presentation (11/20/2023), identifying updated climatology (1950-2012), landfall within 200 miles of Miami, direction variability (landfalling, exiting and bypassing), and peak surge, available data, and surge influence, as key criteria employed in determining the validation storm suite.

APPELLANT: In their appeal letter (7/9/2023) and again in their request for ISRP (1/30/2023) and oral presentations (11/20/2023), the Appellant maintains the inclusion of other validation storms in addition to or in substitution of those selected by FEMA should be considered. The Appellant put forward Hurricanes Frances and Jeanne (2004), as representing storm surges more accurately for the northern SFLSSS model domain, specifically Palm Beach County, with greater empirical data availability, and meeting the other FEMA validation storm criteria. The Appellant provided figures showing the tracks of validation storms compared to those of Hurricanes Frances (Figure 2) and Jeanne (Figure 3).

Figure 2. Tracks of Validation Storms compared to 2004 Hurricanes (screen capture NOAA, 2020) for Hurricanes Frances. (Baird 2020a)

Figure 3. Tracks of Validation Storms compared to 2004 Hurricanes (screen capture NOAA, 2020) for Hurricane Jeanne (Baird 2020a)

FINDING: The Appellant raised a valid consideration and the Panel agrees that inclusion of historical hurricanes Frances and/or Jeanne in the validation storm suite could make the SFLSSS model more accurate, particularly in the northern area of the model domain. However, given the SFLSSS is a regional study, the Panel agrees with FEMA's approach and storm selection criteria, and finds the validation storm suite they assembled to be reasonable and consistent with common practice. Ultimately the Appellant did not provide evidence by way of analysis and mapping that changes in validation storms would affect SWEL or resulting BFEs in Palm Beach County.

7.7. PRIMARY FRONTAL DUNE UPDATES

Positioning of the Primary Frontal Dune (PFD). FEMA guidance requires that the VE zone along the open coast be mapped according to the wave runup, wave overtopping, breaking wave height, or the PFD, whichever is most landward. Consistent mapping of the PFD, which is more often the most landward parameter, is important to consistently defining flood risks within the study area. The Appellant identified several transects that requested FEMA re-analysis based on the Appellants review.

FEMA: In FEMA's appeal response (1/3/2023), it is stated: "The PBC submittal is correct that there may be other reasonable choices for the selection of the dune reservoir that would trigger a different erosion geometry, however additional modeling, mapping, and justification would need to have been provided with the appeal period submittal to support a mapping change."

APPELLANT: The appellant identified several transects related to dune removal procedures and Primary Frontal Dune (PFD) locations. Appellant provided several example figures of transect including the below (Figure 4):

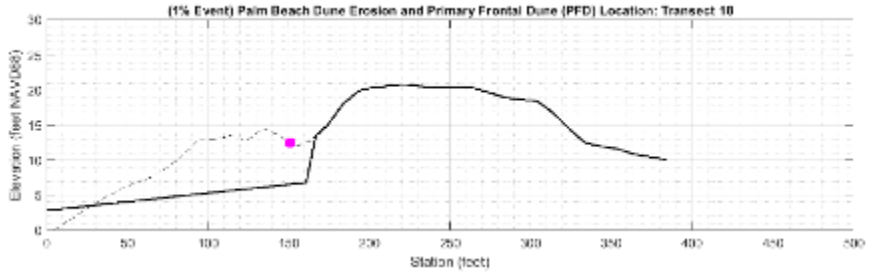

Figure 4. PFD - Transect 18 South of Lake Worth Inlet (Baird 2020b).

FINDING: The Appellant has valid questions regarding FEMA mapping with regards to dune removal and PFD location, however updated analysis and mapping is ultimately required for submittal. The Appellant is correct that the 1:50 slope is standard however, FEMA mappers do have flexibility based on historical eroded profiles. The Panel agrees with FEMA's approach.

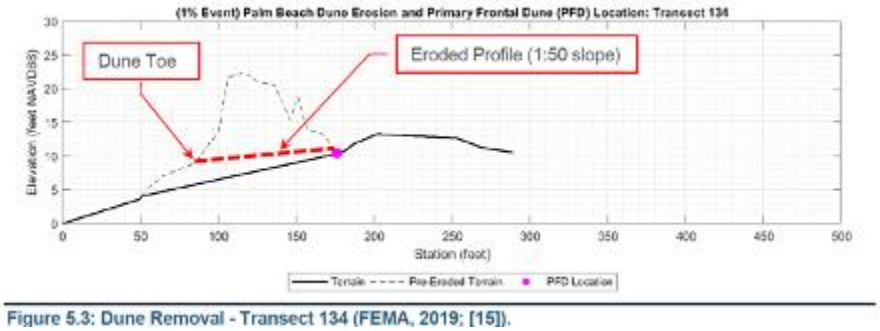

Figure 5.3: Dune Removal - Transect 134 (FEMA, 2019; [15]).

Figure 5. Note that "PFD" heel is identified in FEMA's IDS4-5 as the VE-zone delimiter for Transect 134, therefore the suggested adjusted slope would likely not impact the VE zone gutter position. However the suggested adjusted slope could affect BFEs and/or runup (Baird 2020b).

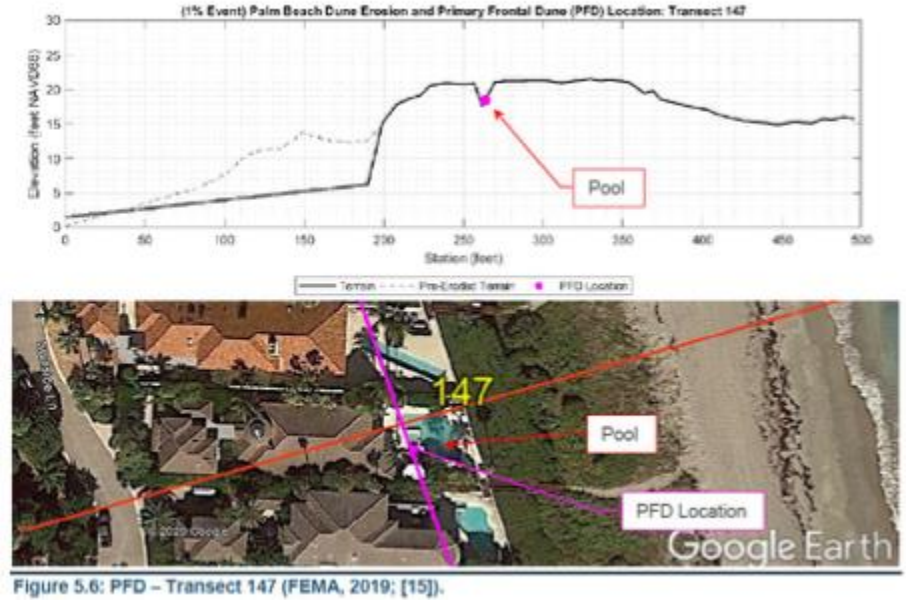

Figure 5.6: PFD – Transect 147 (FEMA, 2019; [15]).

Figure 6: The appellant shows Transect 147 where the PFD crosses a swimming pool. Although not optimal, FEMA guidance does not explicitly oppose this mapping (and stresses mapping continuity) and more analysis is ultimately required to show changes in BFEs and flood zones (Baird 2020b).

7.8. HISTORICAL RECORD CONTEXT

Though there is not a specific series of concerns mentioned in any of the Appellant's materials regarding this issue, it is a common theme carried through many of the documents and appears in numerous

submittals from the Appellant. The Appellant implies that the base flood elevations must be scientifically or technically incorrect because their historical records of water levels do not contain maximum water surface elevations similar to the base flood elevations shown in the Preliminary Flood Insurance Rate Maps.

FINDING: Though there was not a specific point made by the Appellant nor was there a response from FEMA regarding context and applicability of the historical record, the Panel believes it should be addressed. The presence of a historical record that does not contain maximum water surface elevations that are as high or higher than your base flood elevations does not constitute grounds for an argument that the Preliminary Flood Insurance Rate Maps or the Flood Insurance Study are scientifically or technically incorrect or deficient. The historical record of water levels in areas of the US where coastal hazards are dominated by tropical cyclones has little to do with your actual flood hazard vulnerability. Though the historical record is quite important in other areas of the US (e.g., Great Lakes, Pacific Coast) where flood hazards are characterized by the Total Water Level, it has little significance in a place like Palm Beach County. The whole point of the JPM and JPM-OS techniques is to generate a realistic distribution of flood hazard probabilities based on a reasonable distribution of tropical cyclone characteristics. In order to generate the low frequency water levels (1 % and 0.2% annual chance events) needed to derive the floodway designations and hazard elevations, a wide distribution of storm probabilities at the higher and lower storm event frequencies is absolutely necessary. Because of the time-varying nature of the flood map modernization process and the fact that the JPM-OS technique incorporates the time-varying nature of storm event characteristics in the parameter distributions, it is common to see new base flood elevations that are higher than previous maximum floods. The flood hazard statistics along the coast are, therefore, nonstationary and change over time as storm intensity and frequency change and also as mean sea level increases. These are all expected and appropriate outcomes of the flood map modernization process and reliance, in any way, on the historical record of water levels is inappropriate for characterizing the coastal flood vulnerability of a community.

8.0 References

1. W.F. Baird & Associates (2020a). Review & Evaluation of FEMA's Coastal Flood Risk Study: Data and Documents Review Technical Memorandum (Deliverable 4.1) Task Order #1778-01. October 1, 2020.
2. W.F. Baird & Associates (2020b). Review & Evaluation of FEMA's Coastal Flood Risk Study: Data and Documents Review Technical Memorandum (Deliverable 4.1) Task Order #1778-01. October 1, 2020.