



National Institute of  
**BUILDING SCIENCES™**

# Panel Decision and Report

SRP CASCC071719 – Santa Clara County, CA

May 9, 2020

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# 1. Summary

Based on the submitted scientific and technical information, and within the limitations of the Scientific Resolution Panel (SRP), the Panel has determined that portions of the Community's data satisfy NFIP standards and correct or negate FEMA's data.

The Panel has divided its rationale into two parts: Bay Coastline and Highway 237 Embankment.

## BAY COASTLINE

The Panel unanimously determined that portions of the Appellant's (formerly, Santa Clara Valley Water District; now, Valley Water) data satisfies NFIP standards and corrects or negates FEMA's data.

After reviewing the data and documentation provided by Appellant and FEMA, the Panel finds that both parties were deficient in providing thorough data and documentation to support their findings. Further, the Panel finds that Appellant was not duly notified by FEMA of the need for additional supportive data or documentation during the application and appeal time periods. The determination that a portion of Appellant data satisfies NFIP standards and corrects or negates FEMA's data is based on the Panel's technical and professional expertise and experience related to the 2D hydrodynamic modeling approach and the model utilized by Appellant.

The Panel's primary concern with FEMA's approach is the lack of consistency of use of the regional South Bay model (DHI, 2013), which maintains the integrity of all salt pond embankments to produce an expected 1 percent chance water level, combined simultaneously with a procedure to fail all of the embankments for purposes of propagating this water level through the salt ponds to determine the flood zones. Additionally, contributions of fluvial discharges to flooding are neglected in this method. FEMA did not provide joint probability analysis or other documentation to justify this assumption.

The Panel finds that the 2D high resolution hydrodynamic modeling approach used by the Appellant's Consultant, DHI Water & Environment, Inc. (DHI) is a reasonable and more technically correct approach. The Panel has also determined that the Community's approach in identifying the 1 percent chance water levels, including detailed modeling of the local water levels and use of an event-based approach, is more technically correct than FEMA's approach.

The Panel noted deficiencies in the Appellant's documentation of the model application that limited the Panel's capacity to fully evaluate the implementation of this approach, including:

- Supporting documentation justifying the event-based approach (submitted outside of the appeal period, not available to the Panel);

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- Documentation of sensitivity of model predictions to low (subtidal) frequencies in stormwater levels; and
- Lack of joint-probability analysis of 1- percent chance flooding events riverine discharges (or sensitivity analysis with local model, also submitted outside of the appeal period and not available to the Panel).
- Regarding the 2D high resolution hydrodynamic modeling, the Panel finds specifically, the portions of the Appellant's data to satisfy NFIP standards and correct or negate FEMA's data relate to the 2D high resolution hydrodynamic modeling approach used by the Appellant's Consultant, DHI, along with the breach assessments and riverine discharges.

It is relevant to note that the Panel's determination of "satisfies NFIP Standards" was difficult for this portion of the Appeal due to the lack of specific FEMA policies and guidance documents related to acceptable modeling approaches for non-levee systems (embankments) that occurred during and outside of the time elapsed since the Appeal documents were originally submitted. This issue is further discussed in this report.

### THE HIGHWAY 237 EMBANKMENT

The Panel determined that the Appellant's data does not satisfy NFIP Standards; therefore, FEMA's data is not corrected, contradicted, or negated. The Highway 237 Embankment is not designed and constructed to perform as a levee system or flood control structure. The Appellant did not provide analysis and documentation in support of the certification of Section 65.10 of the NFIP.

## 2. Introduction

This report serves as the recommendation to the Federal Emergency Management Agency (FEMA) Administrator from the National Institute of Building Sciences (NIBS) 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. The SRP is charged with helping to efficiently resolve appeal and protest issues between FEMA and communities by acting as an independent third party an effort to obtain the best data possible for the community's Flood Insurance Rate Maps (FIRMs).

### 3. Panel

Panel ID: CASCC071719

Panel Name: Santa Clara County, CA

FEMA Region: IX

Panel members:

- **Dr. Jennifer L. Irish, Professor of Coastal Engineering at Virginia Tech**, is an expert in storm surge dynamics, coastal hazard assessment and nature-based infrastructure for coastal hazard mitigation. Since entering academia in 2006, as lead Principal Investigator (PI) or Co-PI, Irish has received grants totaling \$14.8 million (\$3.2 million for Irish) from agencies including the National Science Foundation (NSF), U.S. Department of Energy (DOE), U.S. Army Corps of Engineers (USACE), the National Commission on Energy Policy (NCEP), and National Oceanic and Atmospheric Administration (NOAA)'s Sea Grant Program. Prior to joining academia in 2006, Irish served as Regional Technical Specialist in Coastal Engineering for the USACE. Irish has published over 50 journal articles and her work has been cited more than 3,000 times (Google Scholar). These contributions have advanced understanding in four areas within coastal engineering and science: airborne lidar bathymetry in the coastal zone; nature-based infrastructure for coastal hazard mitigation; physics of storm surge and related probabilistic hazard assessment; and impacts of sea level rise at the coast. For these contributions, Irish was honored with U.S. Fulbright's Senior Scholar Fellowship and the Department of the Army's Superior Civilian Service Award, among other awards. Established within the international and national engineering communities, Irish is a member of the Virginia Academy of Science, Engineering and Medicine, a Fellow of the American Society of Civil Engineers (ASCE), and a member of ASCE's Coastal Engineering Research Council. She served as Chair of ASCE's Committee on Technical Advancement and as Secretary of ASCE's Coasts, Oceans, Ports, and Rivers Institute Board of Governors.
- **Massoud Rezakhani (Chair), Principal and Owner of MRC LLC**, a Scottsdale, Arizona-based firm with national outreach and resources, has more than 33 years of experience in floodplain analysis, hydrologic and hydraulic modeling and sediment transport analysis for a variety of riverine, alluvial fan and coastal flooding studies and projects at the federal, state, local and private sector level. He is a Certified Flood Manager (CFM) and holds a master's degree in Civil Engineering from George Washington University. He is a member of ASCE, the Association of Floodplain Managers (ASFPM) and the Floodplain Management Association (FMA). Mr. Rezakhani's long work history includes the successful development, design, review, management, and oversight of major coastal and inland watershed restoration projects, drainage/stormwater and flood control

water master plans and studies; flood risk/hazard analysis and mitigation projects; land use/development; and disaster recovery and mitigation programs and projects impacting communities throughout the U.S. He offers extensive expertise and experience with FEMA Flood Insurance Studies (FISs), Floodplain Map Revisions, FEMA levee and alluvial fan policies and impacts. This includes extensive hydraulic and structural design of urban flood control structures. His work has included hundreds of individual projects and Indefinite delivery and indefinite quantity (IDIQ) contracts spanning, but not limited to, the Western United States (U.S.), the Southwest, the Hawaiian Islands, and other U.S. states and territories. Mr. Rezakhani has also contributed to the development and publishing of important flood hazard regulations and policies related to the National Flood Insurance Program (NFIP), Zone AR Restoration Amendment, Levee Certification regulations and National Certification Forms administered by FEMA. His decades of establishing and maintaining strong, positive relationships and experience with regulatory agencies, including with FEMA and other federal, state and local agencies, and serving as a FEMA Liaison, Reviewer and Expert Witness on numerous projects, has led to the successful resolution of many appeals for agencies and applicants located throughout the Nation. This includes serving as a Senior Technical Consultant to the California Governor's Task Force on Alluvial Fan Flooding, which included providing presentations detailing the history of public policy related to managing alluvial fan flooding hazards and helping develop an alluvial fan flooding ordinance for southern California counties.

- **Dr. Elizabeth Sciaudone is a Research Assistant Professor at North Carolina State University, in Raleigh, North Carolina.** She has worked at the university since 2007. Prior to that, she worked in private consulting with Moffatt & Nichol Engineers. She has over 20 years of experience in coastal engineering research and design. Her educational background includes a Bachelor of Science in Engineering (BSE) from Duke University and Masters. and Ph.D. in Civil Engineering from North Carolina State University. She holds a P.E. in the State of Florida. Her project work includes beach stabilization, post-hurricane dune construction, Letters of Map Revision (LOMR), sediment budgets, and coastal highway vulnerability analyses. She has published peer reviewed articles on vulnerability of coastal dunes, identification and analysis of coastal erosion hazard areas, remote sensing of barrier island morphology, and topographic analysis of dune volume and position. She has presented at national and international sediment transport and coastal engineering conferences. Dr. Sciaudone served on the North Carolina Science Panel, advising state regulators on coastal issues from 2010-2018. Her recent research work includes the development of highway vulnerability indicators and dune construction guidelines for overtopping considering a constructed beach berm. She has taught introductory coastal engineering and fluid mechanics courses as well as preparatory courses for the Fundamentals and Professional Engineering (FE and PE) exams.

- **Malcolm Spaulding (Co-Chair), PhD. P.E., F. ASCE, is Professor Emeritus, Ocean Engineering, at the University of Rhode Island (URI) and Principal, Spaulding Environmental Associates (SEA), LLC.** He served for 40 years on the faculty and over a decade as Department Chair. He was founding President of the Northeast Regional Association for Coastal Ocean Observing Systems (NERACOOOS) from 2008 to 2014, and the founder of Applied Science Associates (ASA), Inc. in 1979, serving in various leadership and technical roles through 2014. He was a senior advisor and a lead investigator on the RI Ocean Special Area Management Plan (SAMP) that resulted in the first offshore wind farm in the U.S. He served as a senior advisor to the Rhode Island Shoreline Change (Beach) SAMP and is leading an effort called **STORMTOOLS** to make state-of-the-art modeling systems available to support coastal and riverine flooding analysis in the presence of sea level rise. Dr. Spaulding served on the National Research Council's (NRC) Marine Board and was liaison to the Ocean Studies Board from 1996 to 2001 and has been a member of numerous NRC committees. He served on Scientific Resolution Panels (SRP) for New York City (2016) and San Mateo County, CA (2017). Dr. Spaulding is a registered Professional Engineer in Rhode Island. He was appointed a Fellow by the American Society of Civil Engineers (ASCE) in 2018.
- **Todd L. Walton Jr., Ph.D., P.E., D.CE. (retired) is a consultant in coastal and ocean engineering.** He is a retired faculty member from Florida State University where he was Director of the Beaches and Shores Resources Center, which provided research and engineering storm surge and beach erosion modeling for the State of Florida in establishment of its Coastal Construction Control Line. His past experience includes coastal research and engineering for the Coastal Engineering Research Center (USACE), Waterways Experiment Station (USACE) and Coastal Hydraulics Laboratory (USACE), as well as for numerous consulting coastal engineering companies. He is a past faculty member of Florida State University and University of Florida, as well as an Adjunct or Visiting Professor at George Washington University, Texas A&M University, and Mississippi State University. He has been a member of the U.S. Army's prestigious Tidal Hydraulics Committee, a consultant to FEMA on a seawall guidance manual, a reviewer of FEMA Storm Surge Studies for the Gulf Coast of Mississippi and a member of the National Academy of Engineering (NAE) Hurricane Study Review Team. He has authored over 40 referred technical journal articles in the coastal engineering, coastal erosion and storm surge modeling area, as well as over 100 technical reports and book chapters on coastal engineering subjects. Dr. Walton received his Ph.D. from University of Florida and was a Professional Engineer in the State of Florida for over 40 years.

## 4. Basis for Appeal

With a letter dated June 6, 2016 the Appellant submitted a package of data to appeal the proposed Base (100-year) Flood Elevations (BFEs) shown on the preliminary Flood Insurance Rate Map (FIRM) panels dated July 8, 2015, on the basis that the scientific methodologies for determination of BFEs are over-simplified, over-conservative, and inappropriate for the unique sheltered water coastal setting along the Santa Clara County shoreline. Also, the application of joint occurrence of river discharges and coastal water levels may not have been applied properly, or at all, by FEMA. The Appellant contends that the use of alternative methodologies produces substantially more realistic results while still using conservative assumptions. The Appellant indicates that the DHI's Study approach provides a robust and conservative representation of the former salt ponds and embankments and their impact on flooding and meets and exceeds the NFIP. The Appellant's Appeal was divided into two parts - Bay Coastline and HWY 237 Embankment, as summarized, below:

### BAY COASTLINE

- This part of the appeal was based on an alternative flood study of the Santa Clara County coastline conducted for the Appellant by their consultant, DHI, Inc., dated April 2016. The primary objective of the study was to characterize the possible flood-protection benefits of embankments surrounding salt ponds in the shoreline area. DHI employed a 2-dimensional (2D) hydrodynamic model to estimate storm induced flooding in the area, with assumed partial failure (100-foot breaches) of the embankments for all ponds in the study area. Since the FEMA Study did not explicitly address the potential effects of these embankments on inundation or wave action, Appellant asserts that its study is more scientifically and technically correct.

### HWY 237 EMBANKMENT

- This part of the appeal involves two embankments (levees): The San Tomas Aquino Creek East Bank North Levee and the HWY 237 Embankment. These embankments are not credited on the preliminary Flood Insurance Rates Map (FIRM) Panels as providing 100-year flood protection because they do not meet all requirements of Ch. I, 44 Code of Federal Regulations (CFR), Section 65.10 of the NFIP.

## 5. Data Submitted by the Community and FEMA

The following data was submitted in support of the appeal of Appellant on behalf of the Cities of San Jose and Santa Clara, CA and by FEMA.

### 5.1. APPELLANT

#### 5.1.1. Coastal

- Appeal Letter, dated June 6, 2016, from Dr. Liang Lee, P.E., Acting Chief Operating Officer- Watershed Valley Water
- Final draft report, "Regional Coastal Hazard Modeling Study for South San Francisco Bay", prepared by DHI Water and Environment, Inc., dated January 2013
- Report, "Technical Support Data Notebook for South San Francisco Bay Regional Coastal Hazard Modeling Study", prepared DHI Water & Environment, Inc., dated September 2012, and Appendices A through D
- Digital data submissions including the DHI Mike 21 model files, model inputs, still water models, offshore wave models, nearshore wave models, and mapping both in PDF and GIS shapefiles
- Report "South San Francisco Bay Regional Coastal Hazard Modeling Study prepared by DHI Water & Environment, Inc.", dated April 2016
- FEMA Region IX Response Letter to Valley Water, dated July 6, 2015
- FEMA Region IX Response letter to Valley Water, dated March 20, 2015
- Appellant initial comments on the preliminary floodplain maps to FEMA Region IX, dated August 7, 2015
- A summary memo regarding the review of existing San Francisco Bay Restoration Levee breaches from GEI to Alameda County Flood Control District, dated August 2, 2013
- Appellant internal memo related to review of existing South San Francisco Bay shoreline levee breaches, Project N. 62042049, dated May 4, 2015
- Letter from Appellant discussing the differences between FEMA and Valley Water's coastal hydraulic modeling to FEMA Region IX, dated May 14, 2015
- Agreement between the U.S. Fish and Wildlife Services (USFWS) and the Santa Clara Appellant District (Valley Water) for sediment reuse at South Bay Salt Ponds, signed May 8 and 14, 2014

#### 5.1.2. Riverine

- Appeal Letter, dated June 6, 2016, from Dr. Liang Lee, P.E., Acting Chief Operating Officer- Watershed of Valley Water
- Appeal Enclosure Cover, "Appeal to California Coastal Analysis and Mapping Project: San Tomas Aquino Creek and HWY 237 Embankments", submitted by Valley Water, dated June 8, 2016

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- MT-2 application Form
- Geotechnical investigation Report for San Tomas Aquino Leve Evaluation Project, Santa Clara County, California, prepared by Parikh Consultants, Inc., dated April 2016
- Technical Memorandum prepared by Ms. Emily Zedler, Associate Engineer, P.E., of the Appellant, "Embankment Construction and Freeboard Evaluation", dated June 3, 2016
- Operation and Maintenance Plan for San Tomas Aquino Creek - East Bank Levee, extending about 230 feet north of the Bay Trail, prepared by Ms. Sue Tippets, P.E. CFM, Acting Deputy Operating Officer, Watershed Operation and Maintenance, dated June 6, 2016
- Technical Memorandum, prepared by Ms. Emily Zedler, Associate Engineer, P.E., Ph.D.; Madhu Thummalur, P.E. G.E.; and Liang Xu, P.E., Ph.D.
- CD containing: a copy of State of California, Department of Transportation (Caltrans) Standard Specification, 1992, Section 19: Earthwork; Standard Specifications, Caltrans, dated July 1992: As-Built Plans for State Highway 237 at Calabazas
- Construction plans for San Tomas Aquino Creek from Calabazas Basin to (old) Mt. View-Alviso Road, dated August 13, 1962

### 5.2. FEMA:

- Appeal Resolution Letter, dated June 21, 2019 from Ms. Alison Kearns, Risk Analysis Branch Chief, FEMA Region IX
- Memorandum from Ms. Nicole Metzger, STARR II to Ms. Alison Kearns, Chief, Risk Study Analysis Branch, FEMA Region IX, dated June 21, 2019
- Memorandum from Mr. Seth Ahrens, STARR II to Ms. Alison Kearns, Chief, Risk Study Analysis Branch, FEMA Region IX, dated January 17, 2019

## 6. Summary of Panel Procedures

The work of this SRP (the “Panel”) was performed during the period of February 10, 2020 through May 5, 2020. The panel convened by web conference calls six times during the review period, and once more for the purpose of listening to presentations by FEMA and the Appellant and ask questions. Below is a brief summary of the Panel’s work.

The Panel was officially formed and called to order during a web conference held on February 10, 2020. During that call, which was led by NIBS Institute Director, Ms. Dominique Fernandez, Panelists were informed of the SRP policies and procedures; the scope and responsibilities of the Panel; limitations on material to be reviewed and final decisions; confidentiality; Panel schedule; and use of the SRP website for obtaining Appeal materials. A Panel Chair (Massoud Rezakhani) was appointed during that call.

The Panel next met via a web conference call on February 24, 2020 for the purpose of discussing the reports and data submitted as part of the Appeal process. The primary data sources were summarized in the preceding section. The discussion during this call primarily focused on whether Appellant’s submitted information supported its claims of scientific or technical errors as defined by 44 CFR 67.6. The Panel developed a list of questions for FEMA and the Appellant. These questions (Appendix A) were submitted by Ms. Fernandez to both parties in advance of their presentations to the Panel on March 2, 2020. Responses from FEMA and the Appellant are provided in Appendix A.1 and A.2.

The Panel reconvened by web conference call on March 2, 2020. During that meeting, the panel listened to oral presentations (Appendix B and C) by the Appellant and FEMA (and their designated appointees). That meeting began with an overview of the agenda and information about how the meeting would be conducted, both of which were provided by Ms. Fernandez. Ms. Emily Zedler, Associate Civil Engineer of Valley Water, provided opening remarks, re-stating many of the points raised in the Appeal packages. The Appellant’s representative, Julio Zyserman from DHI, then gave a presentation highlighting work they performed and submitted as part of the Appeal process. A subcontractor for FEMA’s PTS Contractor STARR II, Kris May, Silvestrum Climate Associates, then gave a presentation of work on the Bay Area Coastal Study and provided brief explanations of why the Appellant’s claims lacked merit (Appendix C).

FEMA and the Appellant (Valley Water/DHI) provided written responses to the Panel’s questions on March 1, 2020 and March 10, 2020, respectively (Appendix A.1 and A.2).

The Panel met again by web conference call, on March 11, 2020. The purpose of this call was to review the Panel’s responses to FEMA’s March 2, 2020 oral presentation on the items FEMA listed for denial of the Appellant’s Appeal, and to come up with a preliminary consensus decision on the items presented by FEMA.

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The Panel next met by web conference call on March 25, 2020. The purpose of this call was to review Panel's responses to the Appellant's March 2, 2020 oral presentation from the Appeal, specifically Attachment A of the Appellant's request for the SRP. The Panel also reviewed additional data received from FEMA, specifically the documents referenced in its presentation to the Panel. In addition, the panel reached a preliminary consensus decision on the items presented by the Appellant.

The Panel next met by web conference call on April 3, 2020. The Panel reached a final decision on both the Bay coastline analysis and the HWY 237 Embankment data and documentation. The Panel also reviewed the SRP draft report outline and provided section writing assignments to Panel members.

The Panel met, again, by web conference call, on April 13, 2020. The purpose of this call was to review the draft written sections of the SRP report by Panel members and to ensure responses were complete.

The Panel's last meeting was held by web conference call on April 27, 2020. The purpose of this call was to review the Panel's final draft and incorporate panel members' comments into the report. The Panel also reviewed a chronology of events prepared by and submitted to the Panel by FEMA on April 23, 2020, which included their account of milestones that took place throughout the Flood Insurance Study from April 22, 2013 to the Appeal Resolution letter, dated June 21, 2019. A list of documents referenced in the Appellant's SRP request Attachment A submitted by the Appellant outside the appeal period, is provided in Appendix D. The FEMA chronology of events is provided in Appendix E.

## 7. Recommendation

The Panel divided its recommendations into two parts:

### 7.1. BAY COASTLINE

The Panel agrees that portions of the Appellant's submitted data were technically correct, including the high-resolution hydrodynamic modeling method, breach assessments, and riverine discharges. The SRP Panel was faced with challenges to reach a decision due to concurrences with FEMA that the Appellant's Report included data deficiencies as a result of missing supportive documentation; however, the Panel also concurs with the Appellant that other germane technical and professional sources, guidance documents and studies appear to support portions of the Appellant's Appeal/Study data and findings. In addition, the Panel was not allowed to review some documents referenced by Appellant because those documents were submitted outside of the Appeal period. As the Panel could not review and verify supportive documentations within the Appellant's Appeal, the Panel had to rely on its collective experience and professional judgments to reach this decision. The rationale for the Panel's recommendation is outlined in the subsequent sections.

In brief, the Panel's recommendation is based on two primary reasons. First, that FEMA's approach lacks consistency of use of the Regional South Bay model (DHI, 2013), which maintains integrity of all salt pond /embankments to produce an expected 1- percent chance water level, combined simultaneously with a procedure to fail all of the berms for purposes of propagating this water level through the salt ponds to determine the flood zones. Second, fluvial discharge contributions to flooding are neglected in this method. Neither FEMA nor Appellant provided a joint probability analysis or other documentation to justify their assumptions with regard to riverine discharges. The Panel finds that the Appellant's estimates of 2D hydrodynamic model simulated water levels are more correct as per the basis of the appeal.

### 7.2. HWY 237 EMBANKMENT

The panel determined that the Appellant's data does not satisfy NFIP Standards, thus FEMA's data is not corrected, contradicted, or negated. The Appellant did not provide any analysis and documentations in support of the certification of the highway embankment in accordance with the requirements of the section 65.10 of the NFIP.

## 8. Rationale for Findings

The Panel's recommendation is enumerated and discussed in the six rationale items below.

There is some general overlap among the rationale items presented in this report and those provided by FEMA in response to the appeal. The Panel has developed its own unique comments to serve as rationale for each of the six topics determined to be most relevant:

### 8.1. BAY COASTLINE.

#### RATIONALE 1: SCIENTIFICALLY AND TECHNICALLY CORRECT

The Panel agrees that the Appellant's modeling approach met the NFIP requirements and that its approach is consistent with FEMA guidelines; in particular, with the second sentence of the guidelines discussed below, where the goal is to develop a more correct estimate of the base flood elevations

*FEMA Issues: The Appellant did not present any errors in FEMA's Study.*

FEMA's first item in its denial of the Appellant's request to consider an alternate approach to determining the floodplain area is provided below, citing the relevant section of the FEMA guidelines. This statement was included in both the resolution letter and in FEMA's response to questions from the Panel (Appendix A.1).

44 CFR 67.6 states that the "sole basis of appeal...shall be the possession of knowledge or information indicating that elevations proposed by FEMA are scientifically or technically incorrect."

The Panel notes that FEMA has only quoted the first sentence in the document cited. The full statement under item (a) is provided below ([https://ecfr.io/Title-44/pt44.1.67#se44.1.67\\_16](https://ecfr.io/Title-44/pt44.1.67#se44.1.67_16), accessed on March 4, 2020):

*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***

DHI (2016) stated that *working together with Appellant (they) have proposed an alternative approach whereby all non-accredited levees are breached, instead of fully removed, to provide partial protection not only from waves, but also from tides and storm surge.*

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In response to Panel questions to FEMA dated March 2, 2020, FEMA (Appendix A) stated that it *had multiple meetings with the Appellant about its alternate approach. It was noted that Valley Water's approach could be submitted as an appeal and accepted if the submittal was compliant with FEMA guidelines and standards.*

### **RATIONALE 2: REMOVAL OF ALL EMBANKMENTS FOR DETERMINATION OF OVERLAND SWEL**

The Panel has determined that the approach that the Appellant employed to estimate the 100-year flooding water levels, which included integrating observations of historical events with a 2D high-resolution, hydrodynamic modeling approach, is reasonable to provide estimates for the South Bay Region

*FEMA Issues: Although the Appellant's approach was generally consistent with FEMA's July 2013 Report, "Analysis and Mapping Procedures for Non-Accredited Levee Systems", the submittal was not compliant with this Report*

*The pond berm breaching approach was not consistent with FEMA's July 2013 Report, "Analysis and Mapping Procedures for Non-Accredited Levee Systems"*

The Appellant contends that the method FEMA employs to develop the draft flood maps include the following flaws:

- Assumes that the entire system of embankments for the Study area would simultaneously fail. They note that the chance of this is very low based on a 52-year record of historical events, which showed that most of the embankments remained intact.
- Assumes that the maximum flood level persists for an indefinite period of time, such that all ponds and marshes have time to fill to the maximum offshore water level. The temporal signature for most historical flood events is primarily tidal and hence a steady state solution is over-simplified.
- Assumes a methodology, similar to a natural valley mapping approach, in evaluating the performance of levees. The Appellant suggests that this is an over-simplified and overly conservative approach, given the zero chance of simultaneous failure of all embankments. The approach is not reasonable for such short duration high water events that are characteristic in the Bay. It also seems unreasonable to ignore fluvial discharges in this method.
- Ignores the effects of flow resistance either from bottom roughness or tidal damping through the failed structures.
- Leads to conservative, over-estimation of water levels for inland locations.

FEMA's response was to treat the 2D hydrodynamic modeling method proposed by the Appellant as a Structural Based Inundation Procedure described in FEMA (2013) "Analysis and Mapping Procedures for Non-Accredited Levee Systems" (also known as the Levee Analysis and Mapping Procedure (LAMP)).

## PANEL DECISION AND REPORT

FEMA stated that the documentation submitted by the Appellant does not support the requirements of 44 CFR Section 65.10, *Mapping of areas protected by levee systems*. The principal issues cited include the analysis provided and supporting operation and maintenance plans, structural design standards, and inspection reports.

One of the core issues in this difference of views is how non-levee embankments should be treated. Background levees and dams are specifically designed to retain or direct flood waters. Embankments, on the other hand, have been constructed primarily for reasons other than flood control or attenuation.

There are two primary types of embankments:

1. *Non-levee embankments (NLE)* are typically parallel to the direction of natural flow. These are often highways or railroads built on fill in low lying areas and thus tend to impose lateral constraints on flood flows; and
2. *Non-dam embankments (NDE)* are generally perpendicular to the direction of natural flow and cross over the river or stream. (ASFPM, Association of State Floodplain Managers, Inc., 2011).

The structures in the Santa Clara Study area are historically a result of the construction and operation of salt ponds. They were never designed or constructed to serve as flood control structures. They are best viewed as embankments and not levees

When FEMA conducted its analysis, it assumed that *all non-levee embankments and pond berms would breach or fail in some manner, as they are not accredited flood protection structures and they were not designed, constructed, operated, and maintained as flood control structures.*

*FEMA's (2005) Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States (FEMA's 2005 Pacific Guidelines) specify the analysis procedure for such structures. This procedure is commonly referred to as the "Without Levee Procedure".*

This assumption was evidently made since FEMA has no guidance on how to address areas with non-levee structures (i.e., embankments). FEMA had developed a *"Procedure Memorandum No. 51: Guidance for Mapping of Non-Levee Embankments Previously Identified as Accredited, 2008"*; however, the guidance has since been superseded. In 2019, FEMA introduced an updated document, *"Guidance for Flood Risk Analysis and Mapping: Levees"*, that addresses this issue in Chapter 7.0 Non-Levee Reaches and Non-Levee Features. The chapter concludes with the statement that:

*The flood hazard on the landside of most non-levee features will be analyzed and mapped as not providing base flood hazard reduction.*

It also notes that:

*FEMA has documented several best practices that use various acceptable approaches for modeling and mapping of non-levee features based on standard engineering practice. Individuals should coordinate with the FEMA Regional Office or FEMA Headquarters to discuss flood hazard analysis and mapping requirements that may be appropriate for particular non-levee features.*

This guidance was not available when the Appellant was performing its analysis, and no information is referenced on what constitutes best practices that FEMA cited in its guidance.

It appears that FEMA has reverted to the FEMA Pacific Coast guidance document which treats all embankments using their LAMP (Levees Analysis and Mapping Program), *without levee procedure*.

FEMA guidance for the Pacific region on “without levee” is provided below.

#### ***D.4.7.3.4.1 Levee Failure and Removal***

*Current FEMA policy states that in instances where levees cannot meet the requirements for recognition by the NFIP, the levees shall be “removed” from the analysis. Two scenarios are considered here: 1) a single levee on an analysis transect, and 2) multiple levees along an analysis transect.*

***Single Levee Case*** *If a community cannot provide the Mapping Partner with evidence that a levee is certified as meeting FEMA’s requirements in 44 CFR 65.10, then the Mapping Partner shall remove the levee from subsequent analyses. In such a case, the Mapping Partner shall:*

- 1. Modify the topography along the transect by erasing the levee cross-section and joining the ground elevations on each side of the levee with a straight line.*
- 2. If the Mapping Partner determines that the failed levee provides substantial (but not complete) protection against incident wave action during 1 percent annual flood conditions, the Mapping Partner shall assume no wave action penetrates beyond the failed levee, and that only still water flooding (tide + wind setup) and locally generated waves (i.e., waves generated in the region behind the levee) shall affect the flooded area behind the levee.*

The case for multiple levees follows, but is not provided here, since it simply repeats the above guidance, but for multiple levees.

The other guidance FEMA cites is from the FEMA’s July 2013 Report, “*Analysis and Mapping Procedures for Non-Accredited Levee Systems*”, which states that:

- If FEMA finds that a structure is not a levee designed for flood control, FEMA will not apply the new levee analysis and mapping process (page 3-3)*

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- *While FEMA recognizes that non-levee embankments may in certain situations have a mitigating effect on flooding, if a structure is not designed and operated specifically to provide flood control it is not a levee and therefore is not addressed using the new process (page 3-3)*

In reviewing these guidance documents, it is clear that the procedure that the Appellant (DHI, 2013) used (2D hydrodynamic model simulation with breaches) is not consistent with these guidance documents.

The two areas of difference are:

1. The assumption of the topography (no barrier exists vs. barrier exists but is breached); and
2. The time duration of the flooding (still water level versus. time dependent stormwater level).  
Note that if this constraint is implemented, then the details of the DHI approach, including the number, location, and size of the breaches, are irrelevant, since water levels inside and outside the ponds will, given sufficient time, equilibrate with the still water assumption highlighted above.

FEMA has evaluated the proposed Appellant approach using the without levee, Structural-Based Inundation Procedure. The 2D DHI hydrodynamic modeling approach is clearly not consistent with this FEMA guidance. If FEMA elects to use the existing guidelines, then simulations using time dependent hydrodynamic modeling, with breach failures, cannot be considered. It is unclear what guidance FEMA recommended to the Appellant as they initiated their model-based approach.

### Breaching of Embankments:

The Appellant (DHI, 2016)'s methodology assumed that all pond embankments were instantaneously breached to a width of 100 feet for the base case. The locations were selected to be consistent with historical breaching to the extent that information was available. A sensitivity study was performed with the breach width varying from 50 to 200 ft. The data to support these values was derived from the GEI (2013) study of historical breaches in the south region of San Francisco Bay (Table 1). Breach sizes are provided for external, tidal fluvial, and internal categories. The average width of all breaches is just under 100 feet.  $((125 \text{ ft} + 86 \text{ ft} + 66 \text{ ft})/3 = 92 \text{ ft})$ . The maximum breach width for all types is 175 feet and the minimum is 25 feet. DHI performed a sensitivity analysis with breach width ranging from 50 to 200 feet and showed as the breach width increased the damping effect of flow through the breach decreased. The range of cases selected covers the likely variations in breach width based on observations. Additional simulations were performed that showed that increasing the breach width resulted in water levels in the ponds approaching those adjacent to the salt ponds. This is consistent with well-known inlet basin theory (USACE, 2002), which shows the water levels in the ponds asymptotically approach the water level at the mouth of the breach as the breach width increases. When breaches existed, the GEI (2013) Study showed that the annual average widening rates varied from 3 to 14 feet, with lowest rates for internal breaches and the highest for external breaches.

Table 1: (DHI, 2016, Table 4.1) Statistics of existing breach widths at comparable breach locations (GEI, 2013)

Table 4.1 Statistics of existing breach widths at comparable breach locations (from GEI, 2013)

<i>Breach Type Category</i>	<i>Average Current Breach Width (feet)</i>	<i>Minimum Current Breach Width (feet)</i>	<i>Maximum Current Breach Width (feet)</i>
<i>External</i>	<i>125</i>	<i>100</i>	<i>175</i>
<i>Tidal-Fluvial</i>	<i>86</i>	<i>50</i>	<i>150</i>
<i>Internal</i>	<i>66</i>	<i>25</i>	<i>160</i>

FEMA rejected the results of this analysis based on its interpretation of the Structural Based Inundation Procedure in the LAMP for the size of the breaches and their number and location (Section 4.2.5). The LAMP recommends a minimum breach width of 100 feet for clay and 500 feet for sand. The analysis by GEI showed that most of embankments were composed of clay and silt clay. FEMA noted that a USACE (2015) Study of South Bay pond berms observed that some of the berm crests were loose silt to a loose soil mixture with high organic fiber content. Based on this observation, they suggested that the Appellant should have performed sensitivity tests to breach width. They further stated that the GEI analysis indicated an average breach width of 195 feet and maximum of 675 feet, much greater than the 100 feet that DHI has used.

Some concerns with the FEMA review include the following:

1. According to FEMA LAMP guidelines: *FEMA recognizes that non-levee embankments may in certain situations have a mitigating effect on flooding, if a structure is not designed and operated specifically to provide flood control it is not a levee and therefore is not addressed using the new process. (page 3-3).* Despite this guideline, FEMA evaluated the Appellant Study assuming that guidelines do apply and treated the application using the Structural Based Inundation Procedure. FEMA appears to have offered no alternative guideline to consider the Appellant request.
2. The values cited by FEMA for the average breach width from GEI (2013) mischaracterize the data in two ways: (1) the values cited are for the entire Bay, not the South Bay area, and (2) the values cited are the average and maximum breach width for the external breach types, not all types. They clearly overstate the breach width.
3. FEMA’s review never mentions the results of the sensitivity analyses DHI (2016) performed to investigate the impact of breach width on flooding. DHI covered the likely range of breaches for South San Francisco Bay based on GEI (2013) observations (see Table 1, above).
4. No consideration is given to the fact that DHI (2016) made several very conservative assumptions: (1) that the breaches were instantaneous and (2) that all pond berms were breached, simultaneously. The probability of this occurring is extremely low. It is not possible to calculate the probability of this event based on observations since it has never occurred.

5. No mention is made of the fact that there have been no breaches in the South Bay area during historical extreme water level events when flood protection is most critical.

In its evaluation, FEMA provides no recommendations/guidance to the Appellant of the sensitivity studies that are required or the relevant range of parameters that should be evaluated.

FEMA noted that the berm crest soil type for some embankments from the recent USACE was loose silt to loose soil mixtures. It is not clear how this observation translates into recommendations for breach widths that should be evaluated.

Based on the data available, the Appellant has taken an extremely conservative approach. The approach is so conservative that it does not allow estimates of the return periods for simultaneous, instantaneous breaching of all embankments since there are no observations to support the analysis.

As to FEMA issues related to operation and maintenance plans, structural design standards, and inspection reports, the SRP could find no evidence of these in the material that was provided. The SRP did receive a copy of a Memorandum of Understanding (MOU) between the US Fish and Wildlife Service (USFWS) and Appellant, dated May 2014, for sediment reuse at the South Bay salt ponds. The focus of the agreement is that the Appellant would supply sediments necessary for USFWS to maintain the existing salt pond levees. This presumably represents a portion of an operation and maintenance plan for the embankments.

### RATIONALE 3: IGNORING RIVERINE INFLOWS

The Panel has determined that the approach the Appellant has proposed, using high-resolution hydrodynamic modeling method, is reasonable. The Appellant's selection of breach widths (and range of variability) appear to be fully consistent with historical data for the Study area. Further, FEMA has not provided specific guidance on how embankments (non-levee structures) should be evaluated in their ability to provide flood protection. There was no evidence that the Appellant had provided operation and maintenance plans, structural design standards, and inspection reports for the embankments. Without US Fish and Wildlife Service (USFWS) maintenance plan, the Panel finds that the potential flood reduction benefit of these embankments may not be guaranteed throughout the period the flood maps are in effect. This information may be available; however, the Panel was not provided with that information

*FEMA Issue: Companion precipitation may be underestimated with the five-year freshwater riverine discharges, insufficient documentation.*

The Appellant contended in its Appeal documentation that the FEMA PTS Contractor, Baker AECOM, did not apply further analysis of the joint occurrence of riverine discharges and coastal water levels within the local Study area, other than to tie-in to existing fluvial BFEs (Typically, FEMA uses separate analyses for 1 percent coastal and riverine floodplains, overlaps them, and takes the worst case). It

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notes that the South Bay regional model (DHI, 2013) applied mean river discharges only, and it was stated in DHI's regional model report that the appropriate discharges should be applied in the local analysis (page 29 of DHI, 2013). DHI also performed a sensitivity analysis of the freshwater inflows in the South Bay as part of the regional model development and testing (page 69 of DHI, 2013). Two simulations were performed using the 100-year peak discharge for seven locations for the period of the January 1983 and December 1983 storm events. This analysis showed that the maximum difference in peak water level was less than 0.01 m in most of the South Bay as shown in Figure 1.

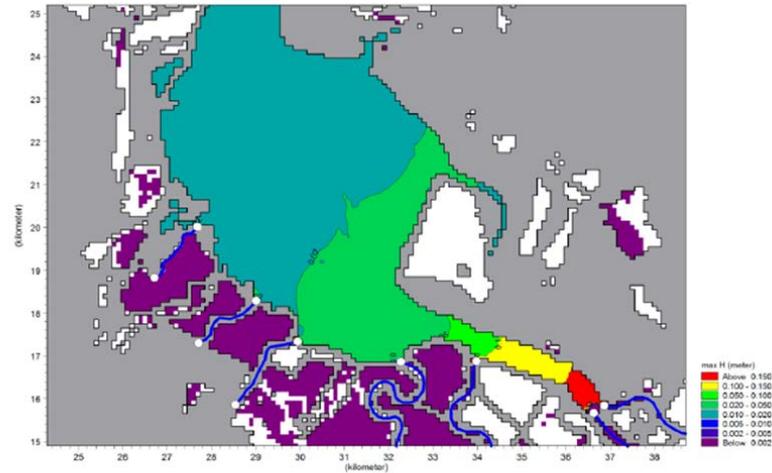


Figure 3.23 Difference in peak water level, (in meters) applying the 100-year Coyote Creek discharge minus baseline simulation. January 1983 storm.

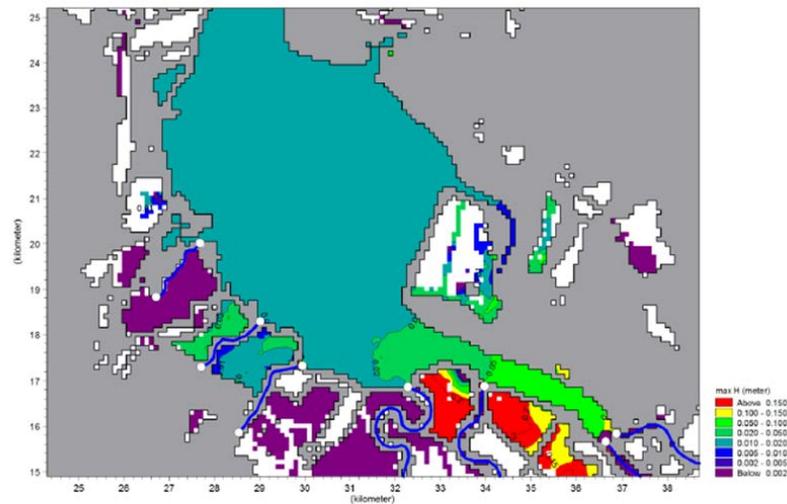


Figure 3.24 Difference in peak water levels (in meters) applying the 100-year South Bay discharges minus baseline simulation. December 1983 storm.

**Figure 1:** Results of sensitivity analysis conducted with the South Bay regional model showing that bay water levels changed very little even when 100-year discharges for January 1983 (top) and December 1983 (bottom) storms were applied. Figures excerpted from DHI (2013)

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In Attachment A of the Appellant's request for the SRP the Appellant noted that, DHI, *together with Alameda County Flood Control District (ACFCD), performed joint analysis of river discharge versus Bay water level for Alameda Creek, where there was a long period of record available to perform the analysis. The analysis demonstrated that the joint occurrence for the 1 percent coastal level is more closely coinciding to a three to five -year river discharge. This information was presented to Baker AECOM in the final comment/response form from ACFCD, but this was submitted after the Appellant submitted its Appeal data.*

FEMA has asserted that the pairing of a five-year freshwater riverine discharge with the synthetic design storm hydrograph was not supported by the submitted documentation. The Appeal denial, dated June 21, 2019, acknowledged that the Appellant assessed the sensitivity of the large-scale regional hydrodynamic model to riverine inflows, but stated that this sensitivity analysis did not include any breaches into the former and current salt ponds. The lack of sensitivity analysis in the local model with breaching included was also noted in FEMA's March 2, 2020 response to Panel questions.

FEMA's oral presentation noted, reported discharges from the January 22-28, 1983 storm event and a February 2-9, 1998 storm event in an effort to show that five-year discharges may not be appropriate. The Appellant's 1983 Report was cited (Slide 39, Appendix B) and it was stated that for the January 22-28, 1983 storm event, the "statistical return frequencies of peak flows for Santa Clara County creeks varied from less than two-years to 25-years." FEMA's presentation (Slide 40, Appendix B) stated that the December 2-5, 1983 storm event did not have accompanying heavy rainfall. FEMA also reviewed a February 2-9, 1998 storm event, and citing the Appellant Report (1998) (Slide 40, Appendix B), noted that, "statistical return frequencies of peak flows for Santa Clara County creeks varied from less than five-years to near 100-years."

In response to Panel questions on March 10, 2020, the Appellant reiterated that FEMA's mapping of the 100-year coastal floodplain did not include significant flows from creeks. Except for inflows from the Sacramento River, for which a 54-year record was used, all inflows from the remaining 20 creeks were set to daily average values. A comparison table (see Table 2 below) was provided for selected creek discharges that were used in both the regional and local South Bay models. These values were also provided in the DHI reports [Table 3.9 of DHI (2013) and Table 3.2 of DHI (2016)]. At that time, the Appellant noted that, typically, FEMA uses separate analyses for 1 percent coastal and riverine floodplains, overlaps them, and takes the worst case. In this case, the Appellant mapped the 1 percent coastal floodplain with the five-year flows and determined tie-in points with the effective 1 percent riverine floodplain, noting that *since coastal and riverine events are generally independent, use of return periods larger than five years cannot be justified.*

**Table 2:** Comparison of freshwater discharges used in the regional model and the DHI South Bay model (Valley Water, 2020)

Creek	Flow in Regional Model (cfs)	Peak Flow in DHI South Bay Model (5 Year Event Peak)
San Francisquito Creek	17	3425
Stevens Creek	13	3799
San Tomas Aquino Creek	24	3775
Guadalupe River	87	6466
Coyote Creek	48	7172

The issue is whether the five-year discharge assumption is appropriate to evaluate the 1 percent coastal flooding. It is recognized that the five-year discharge assumption is more conservative than the assumptions in the regional model used in the FEMA approach. Additionally, the sensitivity analysis performed as part of the South Bay regional model development (DHI, 2013) demonstrated that even considering the 100-year discharges, the water elevations in the South Bay changed by relatively small amounts. However, this sensitivity analysis did not include breaching of the salt pond embankments, which was included in the high resolution 2D hydrodynamic modeling for the Bay Coastline Appeal.

The Panel also reviewed the 1983 and 1998 Santa Clara storm event reports cited by FEMA. An examination of these tables does not show a clear correlation between the elevated storm surge events and high rainfall events. As previously mentioned, the Appellant stated that a joint probability analysis was performed for Alameda Creek; however, this was submitted as part of a different appeal and was outside of the Santa Clara Appeal time period; therefore, this analysis was not considered by the Panel.

The use of the five-year freshwater inflows in the Appellant local 2D modeling is more conservative than the approach in the regional South Bay model where mean discharges were used. Neither FEMA nor the Appellant presented a joint probability analysis to justify their assumptions, but a sensitivity analysis performed as part of the regional modeling indicated that freshwater flows had minimal effect on the Bay water levels. The Panel acknowledged that selection of the 5-year discharges seemed to be a reasonable and conservative approach; however: (1) documentation of joint probability analysis was not provided by the Appellant during the Appeal time period and (2) sensitivity analysis of riverine discharges was not performed with the local model including pond berm breaching. Therefore, the Panel concurs with FEMA that insufficient documentation was provided for this assumption within the 90-day appeal period. If simulations with breaching were performed, reducing the ponds’ water storage capacity then the projected elevations would be lower than the no breaching case, which are already very small. It is noted by the Panel that had FEMA provided the Appellant with the appropriate

and required process of notification and allowances for collaborative consultation this could have allowed the Appellant to resolve these issues in a timely manner.

### **RATIONALE 4: BRIEF RESPONSES TO RECENT COMMENTS FROM STARR AND FEMA REGARDING THE HYDRAULIC ANALYSIS / MAPPING OF FLOOD ZONE.**

The Panel has determined that the use of the five-year freshwater inflows in the DHI Study local 2D modeling is more conservative than the FEMA approach in the Regional South Bay model where mean discharges were used. Neither FEMA nor the Appellant presented a joint probability analysis to justify their assumptions, but a sensitivity analysis performed as part of the regional modeling was reviewed and indicated that freshwater flows had minimal effect on the water levels in the South Bay area.

*FEMA Issue: No separate comment on this was provided by FEMA*

The Appellant responded to various comments raised by FEMA and its PTS contractor. Some of those items have been addressed in the previous rationale discussions. In this section, the panel addresses comments related to WHAFIS and Flood Zones designations.

#### **WHAFIS overland wave propagation analysis**

Based on information and documentation provided to the panel, the Panel finds that the Appellant Valley Water's WHAFIS analysis does not improve upon FEMA's WHAFIS analysis. In FEMA's response, they noted, *many areas in which the carding did not seem appropriate*, and Appellant concurred that this may be the case in its March 10, 2020 written response to SRP questions. As such, the panel agrees that the Appellant's analysis may contain carding errors. However, it is noted that the Panel was not provided any information to independently verify these carding errors. The Appellant indicated in Attachment A of the panel request (Santa Clara County, 2020) that *during the Alameda County Flood Control District comment/response process with FEMA, DHI updated these cards, but also, were able to show that it had no end effect on the actual wave heights*. These changes were made after the Appellant submitted its appeal and FEMA did not notify or provide the Appellant with an opportunity to update these for the Valley Water's Study model. This implies that for other similar studies being reviewed during the same time period, FEMA has not considered similar carding errors as cause for denying an Appeal or Applicant Study/Application.

The Panel also notes that the selection of WHAFIS, though consistent with FEMA guidance, is not an appropriate choice for evaluating overland wave propagation over complex topography, as is the case for embankment breaches. Specifically, WHAFIS, a one-dimensional transect model, cannot capture the alongshore variability in overland wave propagation processes. The Panel further notes that, within the limitations of employing WHAFIS, a more suitable choice of transects would have included both transects adjacent to embankment breaches and transects through the breaches. At present, FEMA

has no guidance in this regard as WHAFIS was meant to be an open coast approach to propagating wave height.

### VE and AE Flood Zone designations

Based on information provided to the panel, data errors related to the Appellant's overland wave propagation analysis with WHAFIS cannot be used to justify VE and AE Flood Zone designations. The PTS Contractor, STARR II Report, dated June 21, 2019, notes that discrepancies between Valley Water's and FEMA's VE and AE flood zone designations *highlights a potential issue with using a time-varying SWEL instead of the statistical SWEL as a reference for the base flood, since SFHAs can theoretically have a lower BFE than a neighboring zone yet have a more restrictive zone designation.* The mapping of Flood Zones AE and VE is considered by the Panel to be relatively minor mapping errors that could be resolved through collaboration between the Appellant and FEMA.

### **RATIONALE 5: EXCLUSION OF ALAMEDA COUNTY FLOOD STUDY / INCLUSION OF ADDITIONAL INFORMATION FROM THE ALAMEDA COUNTY FLOOD CONTROL STUDY**

The Appellant acknowledged that there were Wave Height Analysis for Flood Insurance Studies (WHAFIS) Model carding input errors; FEMA did not provide the Panel with sufficient information to independently verify these carding errors.

*FEMA Issue: The selected synthetic storm event was not documented to be representative of the 1-percent-annual-chance event*

### Response vs event-based approach

In performing the analysis to obtain the 1 percent annual chance event, DHI (2016) initially attempted to perform simulations for the annual maximum water level events over the 54-year record in the Bay. This is the strategy that had been used earlier to determine flooding levels for central and northern portions of the Bay (DHI, 2011). This data would then be used to perform a return period analysis at each shoreline grid point for the Study area to determine the local 1 percent still water elevation level (SWEL). This proved impossible to perform, since many of the weaker storm events in the database did not flood all the grid points adjacent to the shore, and thus did not provide sufficient data to perform a return period analysis. DHI demonstrated this effect by comparing the annual events that gave the highest and lowest water levels. DHI also noted that the return period statistics of the internal ponds were not well represented, using extreme value probability analysis methods, including providing lower pond water levels than observed from the January 1983 storm event (which has the highest water observed, but is less than the 1 percent annual chance storm). To address this challenge, DHI elected to use the 1 percent water elevation at the open boundary of the model and then used the model results to determine the 1 percent SWEL in the Study area. Simulations were performed for the two events with the highest water levels (January 1983 and December 1983) scaled to the 1 percent

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event at the open boundary. These events had different temporal variability, but both were predominated by the underlying tidal signal. The results of the simulation showed that the scaled January 1983 storm event produced a slightly larger inundation extent than the scaled December 1983 storm event. Based on this result and being conservative, the scaled January 1983 storm event was selected.

FEMA pointed out that the Appellant, in using its response and event-based approach, did not demonstrate that they generated the 1- percent annual flood event that considered all contributing factors over the full duration of the event. It noted that the Appellant did not provide an analysis demonstrating that the statistical probability of flood elevation and the durations for the two selected storm events sufficiently characterized the 1- percent annual chance event.

The panel’s review of the top 13 flood events for San Francisco Bay by DHI (2011) (see Table 3) showed that all of the events were dominated by the typical semi diurnal tides, offset by lower frequency forcing representing the storm or flood inducing event.

**Table 3:** (Table 6.6) List of significant storms and associated peak high-water levels at San Francisco (DHI, 2011)

**Table 6.6** List of significant storms and associated peak high water level at San Francisco

<i>Peak High Water Level at San Francisco Presidio</i>		
<i>Storm #</i>	<i>Date and time (LST)</i>	<i>Measured water level (ft NAVD88)</i>
<i>01</i>	<i>27-Jan-1983 10:00 AM</i>	<i>8.88</i>
<i>02</i>	<i>03-Dec-1983 10:00 AM</i>	<i>8.77</i>
<i>03</i>	<i>06-Feb-1998 08:00 AM</i>	<i>8.49</i>
<i>04</i>	<i>10-Jan-2001 11:00 AM</i>	<i>8.13</i>
<i>05</i>	<i>24-Dec-2003 11:00 AM</i>	<i>8.11</i>
<i>06</i>	<i>30-Nov-1982 10:00 AM</i>	<i>7.96</i>
<i>07</i>	<i>17-Jan-1988 09:00 AM</i>	<i>7.88</i>
<i>08</i>	<i>25-Feb-1983 10:00 AM</i>	<i>7.84</i>
<i>09</i>	<i>07-Jan-1993 10:00 AM</i>	<i>7.83</i>
<i>10</i>	<i>16-Feb-1980 11:00 AM</i>	<i>7.80</i>
<i>11</i>	<i>13-Nov-1997 10:00 AM</i>	<i>7.76</i>
<i>12</i>	<i>14-Dec-1997 11:00 AM</i>	<i>7.72</i>
<i>13</i>	<i>10-Dec-1993 11:00 AM</i>	<i>7.72</i>

Figure 2 below shows the water level time series for the January 1983, December 1983, and February 1998 storm events: the top three storms in terms of Bay water levels. The predicted tidal water levels, in the absence of the events, are also shown. The presence of the storm event simply increases the base water level over a short period, less than half a tidal cycle, for the December 3, 1983 storm event and over multiple tidal cycles for the January 27, 1983, and February 6, 1998 storm events. The

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behavior of the other top ranked flood events shows similar patterns (DHI, 2011). Figure 3 demonstrates that these three storm events gave the highest water level over the observed length of the record, with the December 1983 storm event dominating the southern part of the Bay, the January 1983 storm event dominating the central portion of the Bay, and the February 1998 storm event dominating the northern portion of the Bay.

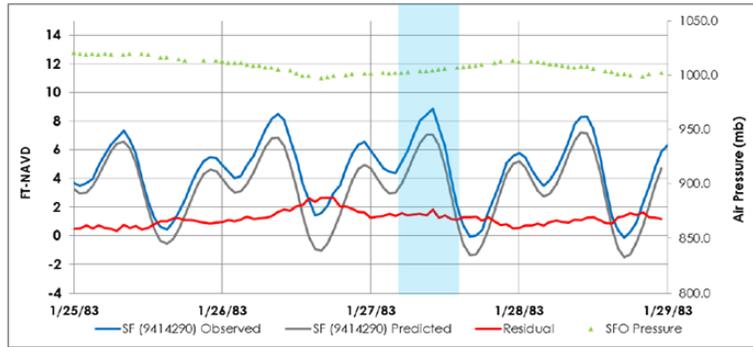


Figure 3-3. January 27, 1983, strong El Niño coastal storm

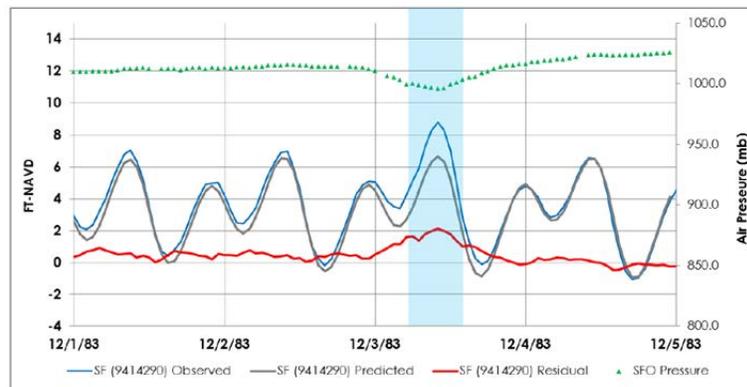


Figure 3-4. December 3, 1983, strong coastal storm

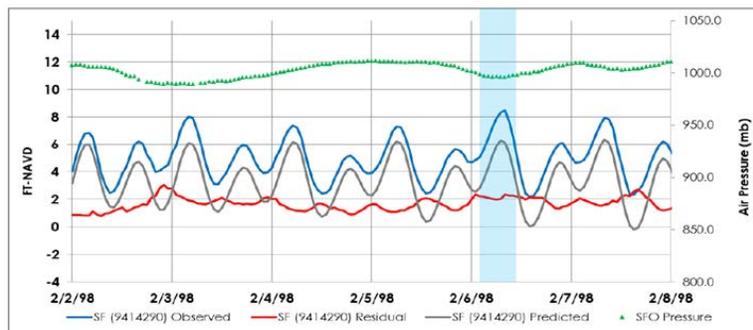


Figure 3-5. February 2-8 1998, strong El Niño coastal storm

Figure 2: Water levels versus time for the January 27, 1983(upper panel), December 3, 1983 (center panel), and February 2-8, 1985(lower panel) storm events. (AECOM, 2016b)

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A comparison between the peak water levels for the two storm events that provide the highest water levels in the Southern Bay vs. distance along the Central Axis of the Bay is shown in Figure 4. Also shown are the Mean Higher High Water (MHHW) and Mean Lower Low Water (MLLW) levels. Finally, the estimated 100-year water levels are shown at the same transect location. The data clearly show the amplification of the tide from the entrance of the Bay to the South Bay Region, in a classic standing wave pattern. The surge from the December 1983 storm events (Figure 2, center panel) shows a similar pattern, with amplification with distance toward the south of the Bay. The January 1983 storm event (Figure 2, upper panel), on the other hand, shows almost a constant offset relative to the MHHW level. The difference between the two events is consistent with the fact that the December 1983 storm event has a duration typical of the tidal cycle, while the duration of the January 1983 storm event is several days long. Tidal theory shows that water level variations on tidal time scales should show amplification for the South Bay and those that have durations substantially longer than tidal time scales should simply result in a uniform adjustment to the water levels.



Figure 3-6. Date of maximum Bay water level (since 1956)

Figure 3 Date of maximum bay water level since 1956 (AECOM, 2016b)

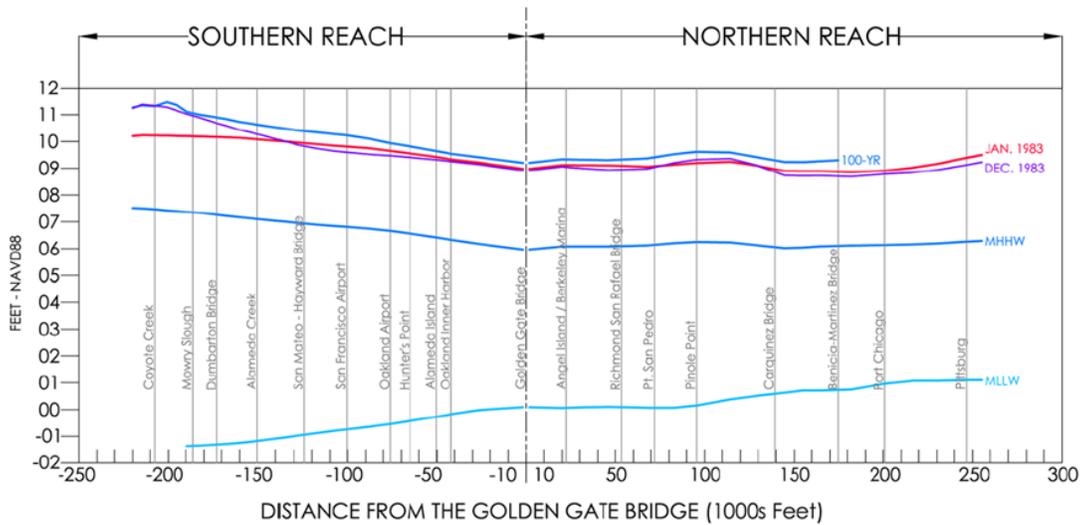


Figure 3-14. Daily and Extreme Tide Elevation Profile in San Francisco Bay

Figure 4: Daily and extreme tidal elevation profiles in San Francisco Bay, CA (AECOM, 2016b)

This review shows that the two events that the Appellant (DHI) selected to use in its analysis represents the two largest events that dominate flooding in the South Bay area within a 52-year historical record. The review also shows that the two storm events represent the range of likely durations for the underlying surge events ranging from tidal to much longer time scales.

From the information provided, it appears that the Appellant has taken a reasonable approach to estimate the 100-year water levels in the Study area. The approach:

1. Addresses the problem of estimating the 100-year surge levels in areas that are not wetted sufficiently frequently, to allow application of return period analyses.
2. Uses 2D high resolution, hydrodynamic modeling techniques to prediction surge levels throughout the entire Study area. (FEMA has strongly supported the use of such modeling techniques to estimate flooding in San Francisco Bay as evidenced by the application of DHI models over the past decade).
3. Employs two storm events that resulted in the highest water levels in the Study area. The two events are representative of other storms in the Study area.
4. The two events selected represent the likely duration of low frequency water level variations from tidal to multiple day time scales.
5. Scaled the results from the model simulations to the 100-yr conditions.

In its Appeal, the Appellant noted that it had provided justification for using the event vs. response-based approach in a DHI Technical Memorandum (DHI, 2017). According to the Appellant Valley

Water, a letter from Baker AECOM, the FEMA PTS contractor, dated June 29, 2017, recommended acceptance of the method. Noting that:

- *The review assessment concluded that the April 24, 2017 submittal demonstrates that the 2-D event-based overland flood modeling approach produces improved 1-percent-annual-chance-flood mapping and wave effects and represents a superior approach to the response-based approach.*
- *Based on our review of the submittal and recent guidance change on event selection methodology, Baker AECOM recommends acceptance of the 2-dimensional (2-D) event-based overland flood modeling for south Alameda County Study Areas 2 and 3.*

The Panel was not provided with a copy of the DHI Report or the Baker AECOM letter since this material was submitted outside of the Appeal time window (Appendix D and E).

## 8.2. HWY 237 EMBANKMENT

### RATIONALE 6: HIGH GROUND CONSIDERATION

Based on the information provided in support of the HWY 237 Embankment, the Panel agrees with FEMA that this portion of the Appeal did not meet the requirements of Section 65.10 of the NFIP. Note that this part of the Appeal is related to riverine flooding along San Tomas Aquino Creek. During the Panel's review of the topographic map for the area south of the HWY 237 Embankment, the Panel noted that use of the BFE of 11.0 feet NAVD (88) should add more area into the Zone X. The Panel recommends that FEMA should re-examine the floodplain delineation of the area.

The Panel has considered the HWY 237 Embankment issues and determined the following:

At present, and to the best knowledge of the Panel, this structure has not been accredited by FEMA (i.e., not yet compliant with 44 CFR Section 65.10, as noted in the FEMA Appeal Resolution Letter dated June 21, 2019). Further, present guidance provided within "*FEMA Publication 95: Guidance for Flood Risk Analysis and Mapping-Levees*", dated November 2019 (Guidance Document 95), Section 7.0 states: *It should also be noted that Federal Highway Administration (FHWA) issued a Memorandum on September 10, 2008, "Highway Embankments versus Levees, and other Flood Control Structures", to its field offices and to state departments of transportation (DOTs), emphasizing that most highway embankments are not designed and constructed to perform as a levee system or other flood-control structure. This memorandum also highlighted the distinctions between highway embankments, levee systems, and other flood-control structures; clarified the FHWA role with respect to flood control; and acknowledged that communities may have incorrectly assumed that these structures provide some level of flood hazard reduction.* Thus, it appears that although HWY 237 is an "engineered fill", it is not a "flood protection structure" and has not been certified (44 CFR, Section 65.10) to be a flood protection

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structure. As a result, based on the information provided to the SRP (that was available and allowable to be reviewed), the SRP agrees with FEMA on this portion of the Appeal.

## 9. References:

AECOM, 2016a. San Francisco Bay Tidal Datums and Extreme Tides Study, Final Report, February 2016.

AECOM, 2016b. Extreme Storms in San Francisco Bay – Past to Present, Final Report, April 2016.

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FEMA, 2008. Guidance for Mapping of Non-Levee Embankments Previously Identified as Accredited, Procedure Memorandum No. 51, (currently superseded).

FEMA, 2013. Analysis and Mapping Procedures for Non-Accredited Levee Systems (also known as the Levee Analysis and Mapping Procedure (LAMP)).

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## PANEL DECISION AND REPORT

SCVWD, 1983. Report on Flooding and Flood Related Damages, Santa Clara County, January 1 to April 30, 1983.

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U.S. Army Corps of Engineers (USACE), 2002. Coastal Engineering Manual, Chapter 6 EM 1110-2-1100 Hydrodynamics of tidal inlets (Part II), April 30, 2002.

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## Appendices

### A.1. APPENDIX A-SRP QUESTIONS TO FEMA AND TO SANTA CLARA COUNTY

## SRP Santa Clara, CA

### March 2, 2020 Oral Presentation Questions for Santa Clara, CA and FEMA Presenters.

#### Questions for the Santa Clara Valley Water District (SCVWD)

##### 1. Model Mesh and Resolution near Breach Locations

In employing the variable mesh DHI 2-D model one needs to refine the grid mesh in the vicinity of the levee and embankments and associated breaches to predict the flows between the various semi-enclosed ponds.

**QUESTION/ASSERTION:** *How did you validate the grid system/model you selected to show that it accurately predicted the flows through these small openings? The figures showing the grid system in the vicinity of levees suggest that the resolution was inadequate to accurately predict the flows for these small-scale inlets.*



Figure 5.7 Detail of flexible model mesh resolution of embankment crests.

**What evidence do you have that indicates that the DHI 2-D Model can accurately predict flows through small scale levee breaches?**

##### 2. Temporal Behavior of Flows through Breaches.

In your analysis, you have assumed that each of the ponds has a breach width of 100-ft in its levee and then run a simulation for the January 1983 Storm Event. This strategy inherently assumes that the levees have some role in flood protection and partially mitigates flooding in the South Bay Area. Inlet (levee breach)- basin (salt pond) hydrodynamics (*USACOE, 2008, Part II-6*) suggest that the inlet functions as a low pass filter, with the reduction in water level inside the pond dependent on both the amplitude and duration of the surge event.

**QUESTION/ASSERTION:** *Have you investigated the impact of the duration of the flooding event on the estimated water level in the pond? If the model is applied to other top ranked storms is its filtering performance*

*changed because of the change in duration of the flooding event?*

### 3. Levees breach locations.

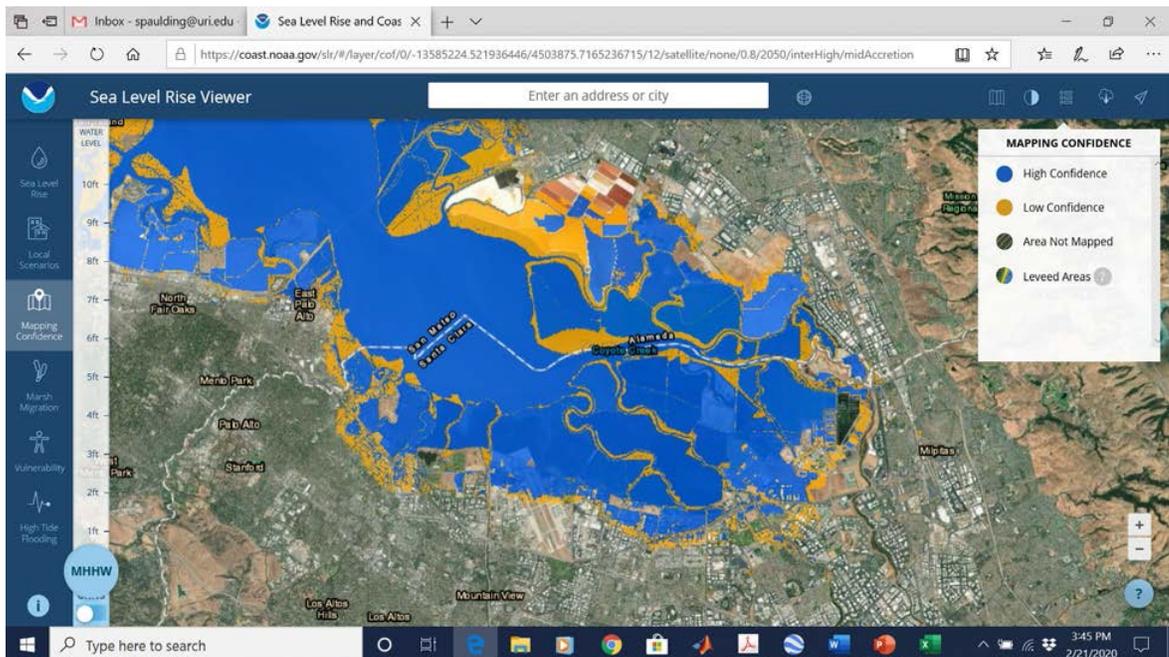
Data from the **GEI (2013) Study** support the idea that breaches of external levees are likely larger than breaches to the internal levees.

**QUESTION/ASSERTION:** *Given this observation why did you not perform a sensitivity analyses where the external levee breaches were larger than their internal/tidal fluvial counterparts?*

*What data or conceptual framework did you develop to support the case for all levees breaching to 100-ft length? Is there any historical support for this? Any theoretical probability projection?*

A review of the NOAA on-line sea level rise mapping tool, shown below for MHHW conditions, suggests that the confidence level in mapping of the topography of the Study Area is low in the vicinity of the levees.

**QUESTION/ASSERTION:** *Has DHI or others performed any simulations that investigate the impact of uncertainty in the topography or any other parameter on the predicted flooding of the South Bay Study Area?*



Source: <https://coast.noaa.gov/slr/#/layer/cof/0/-13585224.521936446/4503875.7165236715/12/satellite/none/0.8/2050/interHigh/midAccretion>

### 4. Request a point-by-point response to the FEMA letter of 21 June 2019 (along with data/info locations in SC data submittal) where FEMA letter is either:

- a. INCORRECT (point out written justification in package already submitted); OR
  - b. INAPPROPRIATE (based on FEMA guidelines)
5. Is there any evidence that FEMA has violated the guidelines provided in their "Coastal Flood Hazard Analysis and Mapping for the Pacific Coast..."? Please reference such evidence.
  6. Is there any evidence that FEMA has not followed the procedural aspects of their "Non-Accredited Levees procedures" (i.e. LAMP publications)? Please reference such evidence.
  7. What is the Santa Clara justification for the "earthen embanked ponds" to be called "levees" in accord with the FEMA and USACE definitions of "levees"??

### **References:**

DHI, 2011. Regional Coastal Hazard Modeling Study for North and Central San Francisco Bay Final Draft Report, October 2011.

DHI, 2013. Regional Coastal Hazard Modeling Study for South San Francisco Bay, Final Draft Report, January 2013.

DHI, 2016. South San Francisco Bay Santa Clara Valley Water District Coastal Hazards Analysis Santa Clara County, CA, April 2016.

GEI, 2013, Summary Memo - Review of Existing San Francisco Bay Restoration Levee Breaches. Appendix D in DHI 2016.

NRC, 2009. Mapping the zone: improving flood map accuracy, Committee on FEMA Flood Maps; Board on Earth Sciences and Resources/Mapping Science Committee; National Research Council, ISBN: 978-0-309-13057-8.

US Army Corp Engineers, 2008. Coastal Engineering Manual (CEM), Parts I and II.

## Questions for the FEMA

### 1. Levee Breaching Assumptions

In DHI's (2011) application of their model to perform a 54-year regional storm surge and wave hindcast of San Francisco Bay, they performed simulations assuming all embankments and levees remained intact and a second simulation assuming they had all failed. The first simulation was based on the assumption that these structures failed, since they are not currently FEMA approved. The second, since they continue to perform a role in flood protection.

Figure 4.5, below, represents with and without levee peak water levels for the January 1983 storm and the next figure represents the difference between the two. The *without* levee case is roughly one or more feet lower than the *with* levee case.

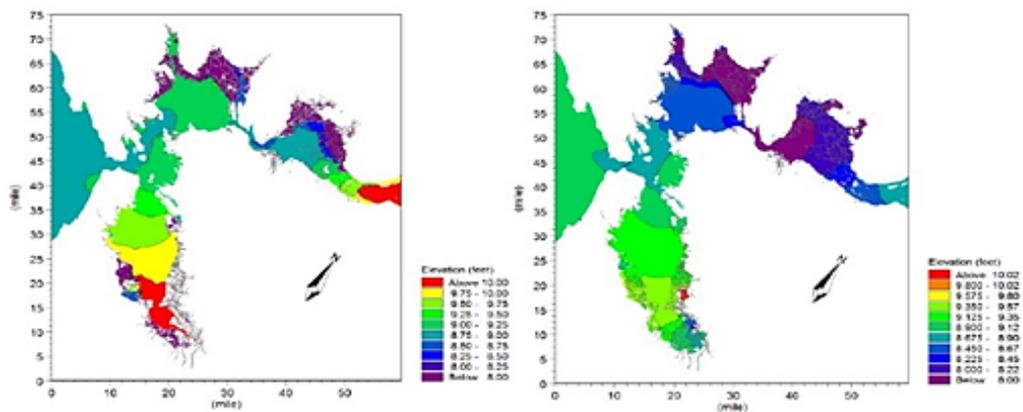
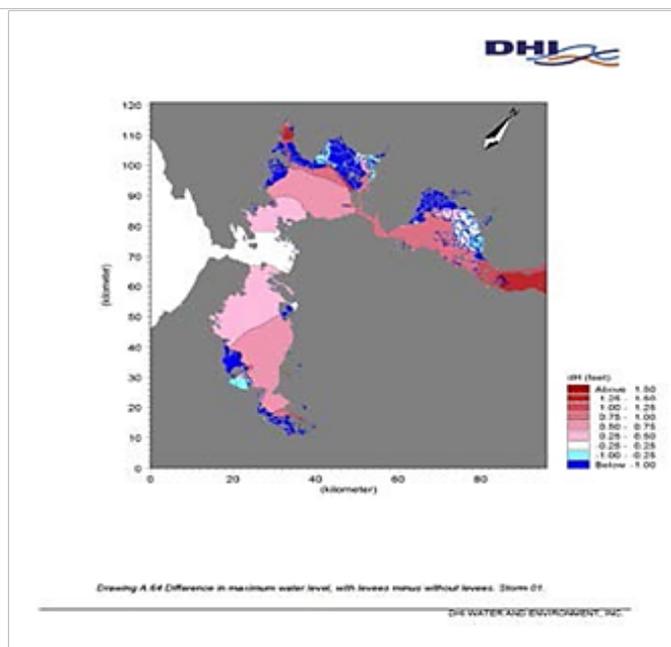


Figure 4.5 Maps of model predicted maximum water surface elevation for a high water event in January 1983. The figure on the left is the model with levees included, and the figure on the right is the model with all levees completely removed.



Drawing A.64 Difference in maximum water level, with levees minus without levees. Storm 01.

From the **DHI (2013) Study for the South Bay:**

### 6.3.1 Model Setup

*It should be noted that the bathymetry represents conditions where all levees are considered intact; this approach was adopted on the basis of results from sensitivity tests that showed that removing all levees from the model grid resulted in a significant under-prediction of storm surge water surface elevations, especially in the extreme North and South Bay areas where significant storage capacity exists behind leved areas.*

**QUESTION/ASSERTION: How does FEMA justify assuming that all the levees function in the case for the entire Bay and when setting the boundary conditions for the Southern Bay analysis? At the same time, how does FEMA assume that the levees all fail for the South Bay and the SCVWD Appeal area?**

## 2. Levee Breaching Widths

According to the **FEMA Appeal Resolution Letter**, dated June 21, 2019:

*pg 4 of 10.*

*For reference, the average width of the breaches observed in the Bay by GEI Consultants (page 10, 2013) was 195 ft and the maximum width observed was 675 ft both significantly greater than the 100 ft breaches applied in Valley Water's study.*

From the **GEI (2013) Study** cited above.

Summary Table – Average Current Breach Widths

Breach Type Category	Number of Breaches Included	Average Current Breach Width (ft)	Minimum Current Breach Width (ft)	Maximum Current Breach Width (ft)
External	15	195	45	675
Tidal-Fluvial	19	101	45	240
Internal	18	74	25	160
Armored	8	161	50	525
Unplanned	2	115	50	180

Average, minimum, and maximum current breach widths for each breach type category include all breach locations considered for this study. As shown in the table, external levee breaches had the highest average current levee breach width while internal breaches had the lowest average width.

The **FEMA Appeal Resolution Letter** appears not to correctly represent the data findings in the **GEI (2013) Study Summary – Average Current Breach Widths Table** in that it does not distinguish that the estimate they cite is not for **all** breaches, but only those that are **External**. It is important to note that this analysis is based on all breaches in San Francisco Bay, including those in the Northern part of the Bay.

Please refer to the below figure from the *GEI Study* that shows the locations of the breached levees.

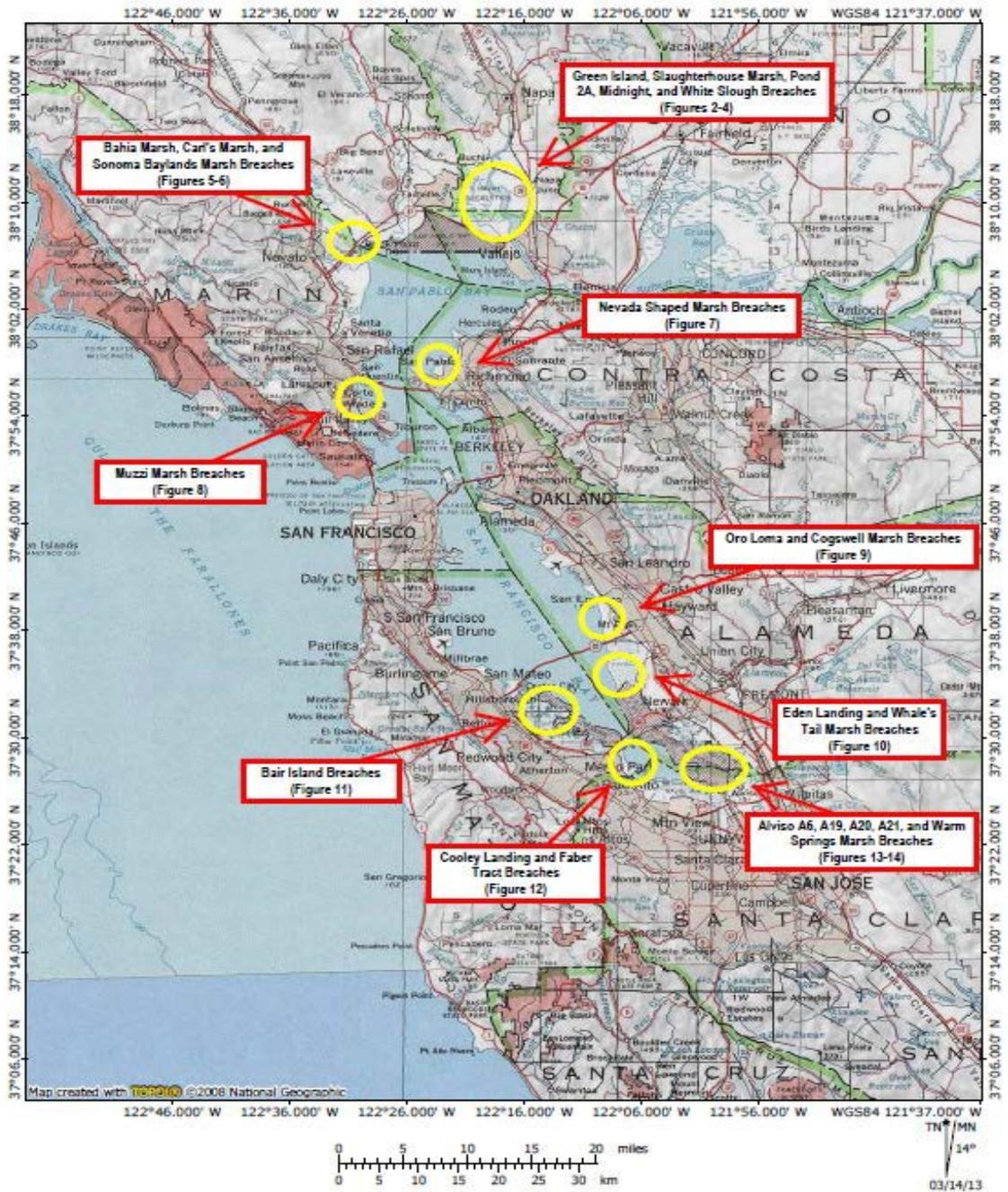


FIGURE 1 - LEVEE BREACH STUDY SITE LOCATIONS

From the **DHI (2016) Santa Clara Valley Report**, we find the following to support their selection of breach width.

Table 4.1 Statistics of existing breach widths at comparable breach locations (from GEI, 2013)

<i>Breach Type Category</i>	<i>Average Current Breach Width (feet)</i>	<i>Minimum Current Breach Width (feet)</i>	<i>Maximum Current Breach Width (feet)</i>
<i>External</i>	125	100	175
<i>Tidal-Fluvial</i>	86	50	150
<i>Internal</i>	66	25	160

This table is consistent with the Table in the **GEI (2013) Study, Section 4.2** (shown below):

Summary Table – Comparable Breach Locations; Average Current Breach Widths

<b>Breach Type Category</b>	<b>Average Current Breach Width (ft)</b>	<b>Minimum Current Breach Width (ft)</b>	<b>Maximum Current Breach Width (ft)</b>
External	125	100	175
Tidal-Fluvial	86	50	150
Internal	66	25	160

In this case of comparable breach locations, and as noted in the caption of the table, are evaluated in the vicinity of Eden Landing (see figure above) representing the Southern portion of the Bay.

**QUESTION/ASSERTION:** *Given this information, isn't DHI's selection of 100 ft reasonable to represent the average width for all levee breaches? (125 ft + 86 ft + 86ft = 266 ft/3= 92 ft)? And for a range in the levee sensitivity study of 50 to 200 ft?*

### 3. Breach Width Sensitivity Testing

According to the **FEMA Appeal Resolution Letter**, dated June 21, 2019:

*Sensitivity analyses, as described in FEMA's Guidance for Flood Risk Analysis and Mapping Levees (February 2019) were not submitted to support the assumptions of breach width, location or number of breaches.*

Quoting from the **DHI Study (2016)**. p 28.

#### *Breach Sensitivity Testing*

*Sensitivity testing was performed for 3 different breach widths of 50, 100 and 200 feet using a MIKE 21 FM HD model. The model is further described in in Section 5. Figure 4.7, Figure 4.8 and Figure 4.9 show the model flood inundation for the 3 breach widths. The tests show increasing tidal damping and flood wave attenuation as the breach width is narrowed.*

**QUESTION/ASSERTION: Why does this analysis not meet FEMA requirements for sensitivity testing for breach width? As to breach number and location, did not DHI's analysis address the worst case, with regard to breaching, since they assumed all levees were breached?**

#### 4. Sustained duration of flooding.

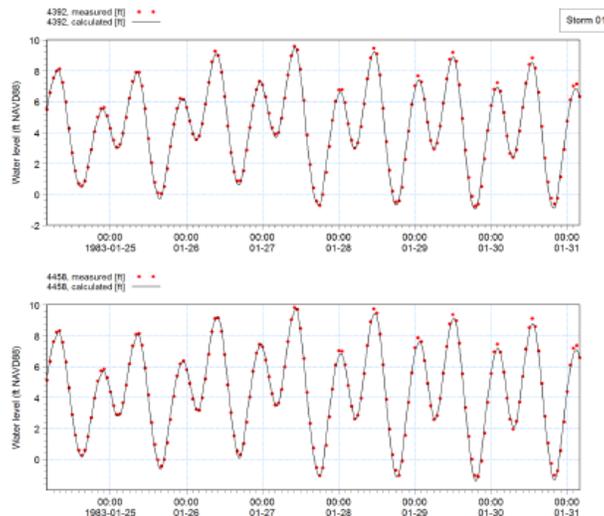
From the **SCVWD Appeal** (Attachment A, Section 4.1)

*The BakerAECOM method assumes the maximum flood level persists for an indefinite period of time such that all ponds and marshes have time to fill to the maximum offshore water level.*

*Since tidal variation is a predictable natural phenomenon, a steady state solution is over- simplified.*

**Inlet- Basin Theory (ACOE, 2008)** demonstrates that inlets act as low pass filters when forced from an adjacent water body, with the filtering characteristics dependent not only on the amplitude of the forcing event (storm surge), but also its time history. The figure, below, shows the calibration of the **DHI (2013)** model for the Jan 1983 event, the event with the largest surge level in the Bay. The observations and predictions show that underlying temporal variation is tidal (semi-diurnal) and dominates the temporal behavior of the event.

**QUESTION/ASSERTION: Why has FEMA then assumed that the surge water level has an infinite period of time to act? Is this not very conservative? Why isn't the application of 2D models with time dependent predictions by DHI a more reasonable way to estimate the flooding potential?**



## 5. Riverine/Coastal Flooding Joint Probability

According to the **FEMA Appeal Resolution Letter**, dated June 21, 2019

*Justification to support the decision to use a 5 yr maximum discharge for freshwater riverine inflows in the 2-D modeling was not submitted. This approach deviates from other FEMA studies and as noted in Item 4, accurately accounting for companion precipitation is required when simulating an approximated 1-percent-annual chance event.*

....

*Valley Water assessed the sensitivity of the large scale regional hydrodynamic model to riverine inflows, showing varying regional influences of the different river systems. The sensitivity analyses did not include breaches into the former and current salt ponds.*

In an earlier study, **DHI (2013)** performed a sensitivity study for freshwater input to the South Bay Area and showed that the 100-year freshwater input resulted in very small changes in the peak water levels. Changes (shown in *Figure 3.24*, below) were generally quite small and typical of uncertainties in the model validation.

**QUESTION/ASSERTION:** *Doesn't this analysis support the idea that even if 100-year freshwater discharges are correlated with the 100-year surge event, that the impact of them is quite low in this area with complex topography? Is it not the case that if levees were breached, that changes in water elevation would be even lower than estimated since the river discharge would be distributed over a wider area?*

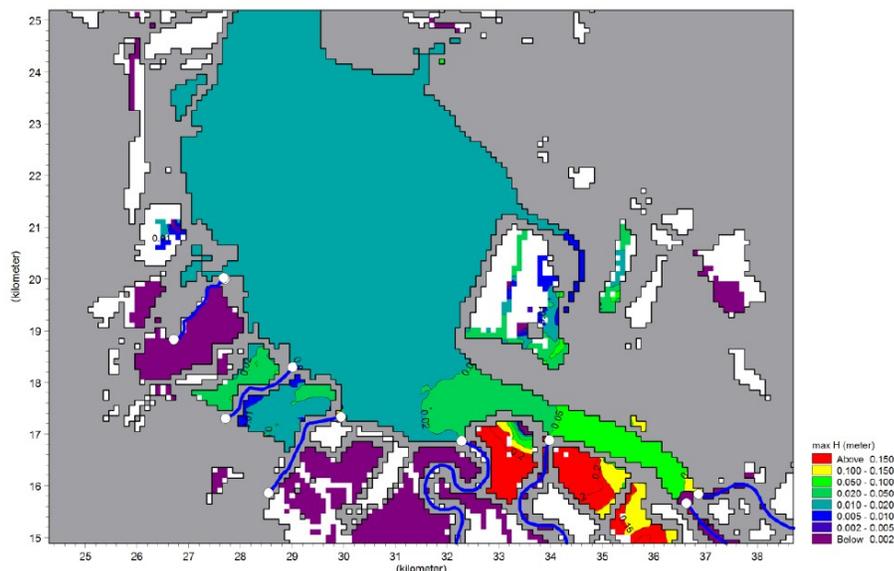


Figure 3.24 Difference in peak water levels (in meters) applying the 100-year South Bay discharges minus baseline simulation. December 1983 storm.

## 6. WHAFIS wave analysis

In performing the wave analysis, both FEMA and SVCWD have elected to use the WHAFIS wave analysis method to estimate wave conditions in the Study area along selected transect lines. The CHAMP WHAFIS method, developed in the 1970s, unfortunately does not address any 2-D wave transformation processes as noted in the National Research Council review (NRC, 2009) and seems poorly suited for the very complicated South Bay application with multiple levees. 2-D wave models are currently available and FEMA approved for coastal analyses (<https://www.fema.gov/coastal-numerical-models-meeting-minimum-requirement-national-flood-insurance-program>) that could be used to perform this analysis. As an example, STWAVE is widely used and readily available from the US Army Corp of Engineers:

*STWAVE is a steady-state, finite difference, spectral model based on the wave action balance equation. STWAVE simulates depth-induced wave refraction and shoaling, current-induced refraction and shoaling, depth- and steepness-induced wave breaking, diffraction, wave growth because of wind input, and wave-wave interaction and white capping that redistribute and dissipate energy in a growing wave field. STWAVE is written by the U.S. Army Corps of Engineers Waterways Experiment Station (USACE-WES).*

**QUESTION/ASSERTION: Why not use a model that is better suited to the clearly two-dimensional (2-D) nature of the wave transformation processes in this complex study area?**

7. FEMA previously used the “without levee” approach to assess flood hazards associated with nonaccredited levee systems. Under the “without levee” approach, Special Flood Hazard Areas (SFHAs) landward of non-accredited levees would be developed as if the levee system did not provide any level of flood-hazard reduction for the 1-percent-annual-chance flood. In essence, landward of the levee system modeling was carried out as though the levee system did not exist.

Under the new LAMP approach, communities with non-accredited levee systems can provide input so that FEMA may select analysis and mapping procedures that better reflect the communities’ unique circumstances and better characterize local flood hazards.

***QUESTION/ASSERTION: Why FEMA did not give any consideration to LAMP Policy when they chose to follow the without levee approach in their Flood Study?***

8. According to the **FEMA Resolution Letter** (item 2 on page 4 of 7), Santa Clara County followed the Structural Based Inundation procedure under the LAMP Analysis. It further states that the documentation provided does not satisfy the requirements of the 44 CFR Section 65.10.

At a Minimum, maintenance plan should specify the maintenance activities and person in charge of maintenance.

***QUESTION/ASSERTION Did FEMA form a Local Levee Partners Team to discuss the appropriate procedure under LAMP Process?***

9. FEMA assumed the berms intact in the San Francisco Bay Regional Analysis and developed extreme tidal elevation. However, they used this extreme tidal elevation and removed the berms for the South Bay and SCVWD Appeal Area.

***QUESTION/ASSERTION: What is the reason for FEMA to use with berm intact for regional analysis but failed them for the local model?***

10. From the **SCVWD Appeal** (Attachment A Section 5, page 5):

The PTS Contractor (Baker AECOM) letter dated June 29,2017 stated that,

*“The review assessment concluded that the April 24 submittal demonstrates that the 2-D event-based overland flood modeling approach produces improved 1percent-annual-chance-flood mapping and wave effects and represents a superior approach to the response-based approach.”*

*“Based on our review of the submittal and recent guidance change on event selection methodology, Baker AECOM recommends acceptance of the 2dimensional (2-D) event-based overland flood modeling for south Alameda County study areas 2 and 3.”*

**QUESTION/ASSERTION: Did FEMA agree with the PTS contractor, Baker-AECOM findings that the DHI's 2-D Model event-based is a superior approach to response-based approach and accepted their recommendation?**

**(Please REFER TO SRP REQUEST SUBMITTAL-ATTACHMENT "A")**

**11.** What is justification for all levees failing simultaneous (paragraph 1 of 4.1).

Is FEMA justified in treating the levees by the ultimate conservative approach of assuming total instantaneous failure?

**12.** Please Provide a response to item 4.2 regarding Riverine Inflows.

**13.** Please respond to item No.4.3

**14. Information Not Considered**

In their request for an SRP, dated July 17, 2019, the SCVWD District has indicated that FEMA evidently did not consider some information provided by the District because it was submitted outside the window for the Appeal period. These documents are listed in Attachment A of the request.

These have not been provided to the Panel, to date.

**QUESTION/ASSERTION: Is FEMA/SCVWD going to provide these documents to the SRP and should they be considered in the Panel's deliberations?**

- ***From Attachment A, July 17, 2019 Panel Request Letter***
- ***A list of proposed references to be included as part of the information for the SRP is provided here.***
- ***/1/ Alameda County Basis of Appeal Memo to FEMA, August 2018***
- ***/2/ DHI, 2017. Technical Memorandum: Event Based versus Response Based Coastal Analysis in southern Alameda County. Submitted to ACFCWCD, 20 April 2017/3/ DHI, 2017. South San Francisco Bay Alameda County Coastal Hazards Analysis. Report by DHI Water & Environment for FEMA Region IX and Alameda County Public Works Agency. July 2017.***
- ***/4/ Event Based Acceptance Memo from Baker AECOM dated 2017.06.29***
- ***/5/ Most recent Comment & Response Forms between from DHI/ACFCD to FEMA Baker AECOM; and***
- ***DHI Appendix to Comment Response form dated 2016.02.08***

## References:

DHI, 2011. Regional Coastal Hazard Modeling Study for North and Central San Francisco Bay Final Draft Report, October 2011.

DHI, 2013. Regional Coastal Hazard Modeling Study for South San Francisco Bay, Final Draft Report, January 2013.

DHI, 2016. South San Francisco Bay Santa Clara Valley Water District Coastal Hazards Analysis Santa Clara County, CA, April 2016.

GEI, 2013, Summary Memo - Review of Existing San Francisco Bay Restoration Levee Breaches. Appendix D in DHI 2016.

NRC, 2009. Mapping the zone: improving flood map accuracy, Committee on FEMA Flood Maps; Board on Earth Sciences and Resources/Mapping Science Committee; National Research Council, ISBN: 978-0-309-13057-8.

US Army Corp Engineers, 2008. Coastal Engineering Manual (CEM), Parts I and II

###

**A.1.1. APPENDIX A.1-FEMA Responses to SRP Questions**

## Santa Clara County, CA Scientific Resolution Panel (SRP)

March 2, 2020

### FEMA's Answers to the Panel's Questions

The SRP submitted questions to FEMA via NIBS on February 27, 2020.

Below are FEMA's responses to those questions.

FEMA will respond to these questions orally during the Question & Answer segment of the Oral Presentation Session scheduled for March 2, 2020. The responses below are intended to support FEMA's oral answers, and they provide additional back-up information to support potential follow-up questions from the SRP. For some SRP questions, the additional back-up information has been organized based on subcomponents of the question, as noted in red as (a), (b), (c), and (d) within the re-stating of each SRP question below. The FEMA San Francisco Bay Area Coastal Study has a lengthy history, and the answers and back-up information reflect some of the history and complexity of the study.

This document includes the questions posed by the SRP to help orient the reader but does not provide the additional detail and back-up information submitted by the SRP to support each question.

## 1 Levee Breaching Assumptions

*SRP Question: (a) How does FEMA justify assuming that all the levees function in the case for the entire Bay (b) and when setting the boundary conditions for the Southern Bay analysis? At the same time, (c) how does FEMA assume that the levees all fail for the South Bay and (d) the SCVWD Appeal area?*

### **Response:**

FEMA assumed that all levees, non-levee embankments, and pond berms remain intact in the regional hydrodynamic modeling, both for the original regional modeling completed in 2011 that was calibrated and validated to represent hydrodynamic conditions in the North and Central Bays (DHI 2011), and for the updated regional modeling completed in 2013 that was calibrated and validated to more accurately represent the South Bay (DHI 2013). No boundary conditions were extracted from the 2011 model to support the 2013 model in FEMA's analysis.

FEMA assumed that all non-levee embankments and pond berms would breach or fail in some manner, as they are not accredited flood protection structures and they were not designed, constructed, operated, and maintained as flood control structures. FEMA's (2005) *Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the*

*United States* (FEMA’s 2005 Pacific Guidelines) specify the analysis procedure for such structures. This procedure is commonly referred to as the “Without Levee Procedure”.

The 1-percent stillwater elevation penetrates through the structure, although no wave action penetrates beyond the structure. Only the 1-percent stillwater elevation and locally generated waves shall affect the next landward levee (in the case of multiple levees). This process is taken into consideration in the one-dimensional WHAFIS analysis. This procedure is consistent with the Natural Valley Procedure described in FEMA’s (2013) report *Analysis and Mapping Procedures for Non-Accredited Levee Systems* (FEMA’s 2013 report). The Without Levee / Natural Valley Procedure is intended to represent a floodplain that is an ensemble of an infinite number of potential breach or failure scenarios without the cost of analyzing an infinite number of scenarios.

FEMA’s analysis for the entire Bay, the South Bay, and the SCVWD appeal area is consistent and compliant FEMA’s guidelines and standards.

#### **Additional Back-up Information:**

**Response 1a.** *How does FEMA justify assuming that all the levees function in the case for the entire Bay?*

The regional hydrodynamic modelling that provides the input to the one-dimensional WHAFIS and wave-runup analyses assumes the pond berms and non-levee embankments remain intact (as shown on the left in Figure 4.5, DHI 2011). The sensitivity analysis shown in DHI’s report (2011) with all pond berms removed from the model (shown on the right in Figure 4.5, DHI 2011) was not specifically requested by FEMA. This sensitivity analysis was completed by DHI to highlight the importance of retaining the pond berms in the regional San Francisco Bay model. Having this simulation represented in DHI’s report (2011) has led to significant stakeholder confusion throughout the FEMA San Francisco Bay Area Coastal Study process as to how FEMA treats non-levee embankments and pond berms.

The pond complexes in the North and South Bays include extensive storage areas that would reduce Bay water levels if all pond berms and non-levee embankments were removed at once, as reflected in Figure 4.5 on the right. However, removing all pond berms entirely in the simulation represents an extreme and unrealistic situation that would not occur in nature. This assumes the pond berms would disappear in their entirety if they were to fail. However, pond berms, non-levee embankments, and levees generally fail at specific weak points along a reach. Predicting the exact timing and location of a breach is not possible unless it is a specific design feature of the system (FEMA 2013).

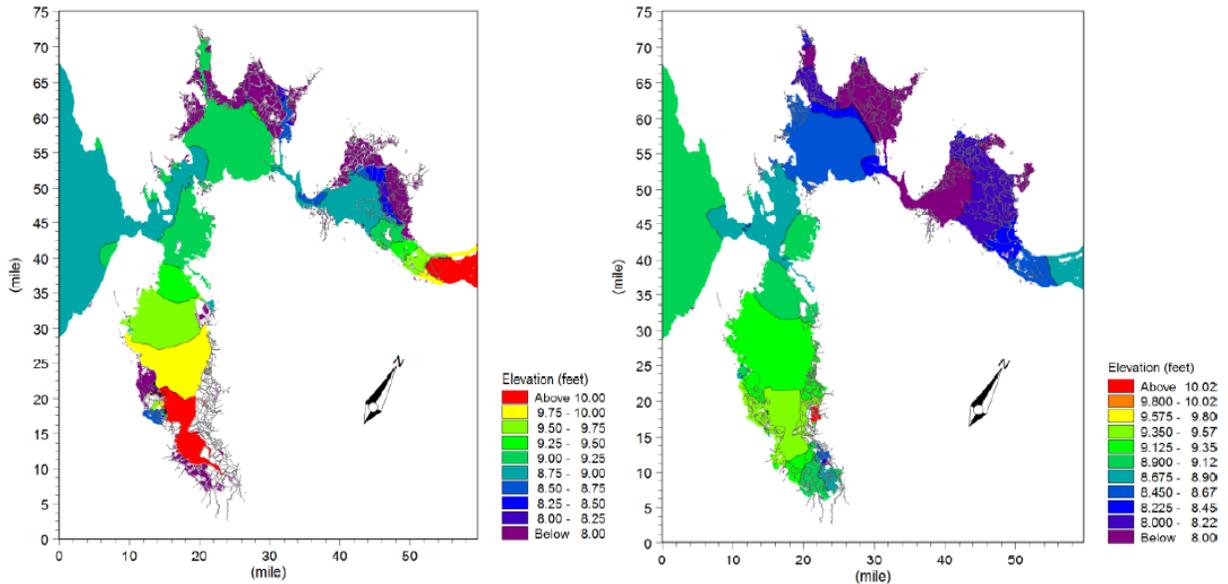


Figure 4.5 Maps of model predicted maximum water surface elevation for a high water event in January 1983. The figure on the left is the model with levees included, and the figure on the right is the model with all levees completely removed.

Source: DHI 2011

Regardless of the mode or location of pond berm failure, the majority of the structures would remain in place. Therefore, the simulation completed by DHI (2011) and shown on Figure 4.5 on the left with all pond berms intact provides a more accurate depiction of what the Bay water levels would be when pond berm failures occur. The model output from the scenario shown on Figure 4.5 on the left (pond berms intact and represented in the regional hydrodynamic model) was used as input to the FEMA one-dimensional coastal analysis, including overland wave propagation and wave-runup calculations, for the North and Central Bays.

**Response 1b.** *How does FEMA justify assuming that all the levees function when setting the boundary conditions for the Southern Bay analysis?*

FEMA did not extract boundary condition data from DHI (2011) to set boundary conditions for the South Bay or to conduct any coastal analysis in the South Bay.

DHI (2011) notes that “the model results south of the San Mateo Bridge should not be used for analysis.” Santa Clara County, southern Alameda County, and southern San Mateo County are located south of the San Mateo Bridge. Although the South Bay was included in the original regional hydrodynamic model to ensure accurate model calibration and validation in the Central and North Bays, the South Bay hydrodynamics are complex, and an update to the model was required to better approximate South Bay hydrodynamic and wave conditions.

Originally (in Phase 1 of the FEMA San Francisco Bay Area Coastal Study in 2004), it was assumed that the USACE would model and map the flood risk in the South Bay through the South San Francisco Bay Shoreline Study<sup>1</sup>, and FEMA would adopt the USACE mapping for flood insurance rate map purposes. However, due to complexities and complications unrelated to the SRP process, the FEMA and USACE studies diverged. FEMA then retained DHI to update the regional hydrodynamic model to better represent the South Bay so the South Bay could be mapped consistently with the rest of the Bay. The updated model includes the entire San Francisco Bay since the entire Bay works as a complete physical system (DHI 2013). No boundary conditions were extracted from the North/Central Bay 2011 model (DHI 2011) and applied to the South Bay (DHI 2013). The South Bay simulations assume all pond berms remain intact in the 54-year long simulations.

The South Bay model report (DHI 2013) and model output only contains results for the South Bay because long-period ocean swells coming through the Golden Gate (the narrow entrance to the San Francisco Bay that is spanned by the Golden Gate Bridge) were not included in the simulations. The swells were not observed to penetrate to the South Bay. Therefore, South Bay model results are only used in the South Bay, and the Central and North Bay model results are only used for the Central and North Bay.

**Response 1c.** *How does FEMA assume that the levees all fail for the South Bay?*

FEMA analyzed the South Bay in the same manner as the North and Central Bays. All pond berms and non-levee embankments remain in the regional hydrodynamic model updated to better represent the South Bay (DHI 2013). For the one-dimensional analysis, FEMA applied the Without Levee / Natural Valley Procedure described in FEMA's 2005 Pacific Guidelines and FEMA's 2013 report. In the one-dimensional WHAFIS analysis, it is assumed that the pond berms and non-levee embankments would fail at some point along the structure.

The Without Levee / Natural Valley Procedure is not intended to represent a scenario where all pond berms fail at once. The Natural Valley Procedure is intended to represent a floodplain that is an ensemble of an infinite number of potential breach or failure scenarios, without the cost of analyzing an infinite number of scenarios. Application of this procedure is appropriate in this area because the pond berms are not designed, operated, and maintained for flood control purposes, as described in FEMA's 2005 Pacific Guidelines and FEMA's 2013 report

The following excerpts are from FEMA's 2005 Pacific Guidelines, which governed the analysis procedures used in FEMA's San Francisco Bay Area Coastal Study.

*“For any protective effects of coastal levees or levee systems to be recognized by the National Flood Insurance Program (NFIP) and incorporated into flood hazard maps,*

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<sup>1</sup> <http://www.southbayshoreline.org/about.html>



*they must be designed, constructed, operated, and maintained to resist erosion and prevent any flooding or wave overtopping landward of the levee crest during 1% annual chance flood conditions; also, the levee or levee system must be certified as providing that level of protection. NFIP regulations (44 CFR Part 65.10) detail the requirements for a levee to be recognized as providing protection from flooding” page D.4.7-9, FEMA (2005)*

*“Current FEMA policy states that in instances where levees cannot meet the requirements for recognition by the NFIP, the levees shall be “removed” from the analysis.” page D.4.7-14, FEMA (2005)*

*“If the Mapping Partner determines that the failed outer levee provides substantial (but not complete) protection against incident wave action during 1% annual flood conditions, the Mapping Partner shall assume no wave action penetrates beyond the outer levee, and that only still water flooding (tide + wind setup) and locally generated waves (i.e., waves generated in the region behind the levee) shall affect the next landward levee (see Figure D.4.7-8).” page D.4.7-15, FEMA (2005)*

FEMA’s 2013 report re-confirmed the approach specified in FEMA’s 2005 Pacific Guidelines:

*“Non-accredited levees subject to coastal flood forces will be fully intact within the storm surge model setup to determine peak storm-surge elevations seaward of the levees. In these situations, consideration will be given as to how the levee system will impact wave propagation. A steady-state condition will then be assumed landward of the levee, and the 1-percent-annual-chance WSEL will be extended landward of the non-accredited levee until it intersects the ground elevation, or the levee on the opposite side, in the case of a ring levee.” page 4-20, FEMA (2013)*

**Response 1d.** *How does FEMA assume that the levees all fail for the SCVWD Appeal area?*

FEMA treated the appeal area in the same manner as the other 8 Bay Area counties. All 9 Bay Area counties have salt ponds, former salt ponds being restored, nearshore ponds or lagoons with non-levee embankments, or agricultural areas separated from the Bay by non-levee embankments. All non-accredited structures are treated the same in FEMA’s study. The FEMA study is consistent with FEMA’s guidelines and standards.



## 2 Levee Breaching Assumptions

*SRP Question: Given this information, (a) isn't DHI's selection of 100 ft reasonable to represent the average width for all levee breaches? ( $125\text{ ft} + 86\text{ ft} + 86\text{ ft} = 266\text{ ft}/3 = 92\text{ ft}$ )? (b) And for a range in the levee sensitivity study of 50 to 200 ft?*

### Response:

FEMA asserts that additional sensitivity testing is required for compliance with the Structural Based Inundation Procedure described in FEMA's July 2013 report. The goal of the procedure is to reasonably represent the 1-percent-annual-chance flood hazard, not to reasonably represent the average breach width. As described for this procedure:

*"It is expected that breach width will be the most widely tested parameter during the sensitivity analysis." page 4-17, FEMA (2013)*

As further described:

*"As the parameters are varied, the impacts to the peak discharge, volume through the breach, and the SFHA will be noted. In general, the final parameters chosen will represent the most reasonable flood hazard area." page 4-17, FEMA (2013)*

Based on the documentation submitted, the sensitivity analysis is not compliant with the Structural Based Inundation Procedure described in FEMA's July 2013 report.

GEI's 2013 memorandum presents a *Review of Existing San Francisco Bay Restoration Breaches*. Restoration breaches are planned breaches that are excavated to introduce tidal flows and support restoration goals. The breaches referenced in the Structural Based Inundation Procedure are not planned restoration breaches. They are breaches that result from levee failure. GEI (2013) references 2 unplanned breaches, one 50-foot wide and one 180-foot wide. FEMA asserts that using average breach widths based on this limited data set is not sufficient when analyzing the 1-percent-annual-chance flood risk in a highly urbanized area such as Santa Clara County.

FEMA's July 2013 report notes:

*"add additional breach locations to the initial locations if additional breaches can change the flood elevations or the extent of the composite floodplain significantly" page 4-15, FEMA (2013)*

Based on the sensitivity testing submitted, it is unknown whether or not breaches wider than 200 feet would have resulted in significant changes in the flood elevations or the composite floodplain.

### **Additional Back-up Information:**

**Response 2a.** *Isn't DHI's selection of 100 ft reasonable to represent the average width for all levee breaches?*

The Structural Based Inundation Procedure describes the approach for testing the number, the locations, and the sizes of the breaches. Documentation has not been submitted to support the selection of 100-foot wide breaches based on the requirements of the selected procedure.

The GEI (2013) memorandum presents a review of restoration breaches. Breaches to support restoration efforts are generally excavated (at a width of ~50 feet) through a pond berm to introduce tidal flows through the opening and support restoration goals (see the photo taken after a restoration breach was excavated at the Islands Ponds in the Santa Clara County pond complex).



Photo taken by Kris May (circa 2008) after the Island Ponds were breached to allow tidal circulation.

Restoration breaches may remain at their original excavated width until a large storm occurs and the breach widens due to scour and erosion. How quickly or how slowly the breach widens is based on many factors, including the storm intensity, the wave conditions the berm is exposed to, and the integrity or strength of the pond berm at the breach location. The location of a restoration breach is selected to support restoration goals, and the planned breach may or may not be located at the weakest spot in a pond berm where a storm-induced breach is most likely to occur.

The breaches referenced in the Structural Based Inundation Procedure are intended to represent levee failures. GEI (2013) references 2 unplanned breaches: one is 50 feet wide and

one is 180 feet wide. Based on this limited data set, it is unclear if 100-foot breach widths meet the requirement of the Structural Based Inundation Procedure.

FEMA's July 2013 report notes that *minimum* breach widths should be 100 feet for clay levees and 500 feet for sand levees. Soil analysis performed by GEI Consultants (2013) concluded that the pond berms were composed of clay to silty clay material. During the USACE (2015) field assessment of the South Bay pond berms, it was found that the soil composition of the dike crests ranged from loose silt to a loose soil mixture with high organic fiber content, indicating a high potential for erosion at points along the berm crests; therefore, modeling a wider range of breach widths would be more appropriate to account for the variations in soil type from silt to clay.

FEMA asserts that using the minimum breach width for clay levees from FEMA's July 2013 report, using average breach widths based on limited data, and using average breach widths for planned restoration breaches, is not sufficient when analyzing for the 1-percent-annual-chance flood risk in a highly urbanized area such as Santa Clara County.

**Response 2a.** *And for a range in the levee sensitivity study of 50 to 200 ft?*

FEMA asserts that the sensitivity analyses completed were not compliant with the Structural Based Inundation Procedure (FEMA 2013). The Procedure states:

*“add additional breach locations to the initial locations if additional breaches can change the flood elevations or the extent of the composite floodplain significantly”*. page 4-15, FEMA (2013)

The Appellant completed sensitivity analysis with 50 foot, 100-foot, and 200-foot breaches and compared the water levels in the ponds (DHI 2016). Figure 4.14 from DHI (2016) shows that as the breach width is increased, the water level elevations within the ponds increase, and the water level elevations on the outboard side of the breach decrease. However, it is not clear if the above requirement for no significant change in flood elevations was met the sensitivity analysis presented in Figure 4.14 from DHI (2016). In addition, the selection of a 100-foot breach over the 200-foot breach is not supported if the intent of the modeling effort is compliance with the Structural Based Inundation Procedure.

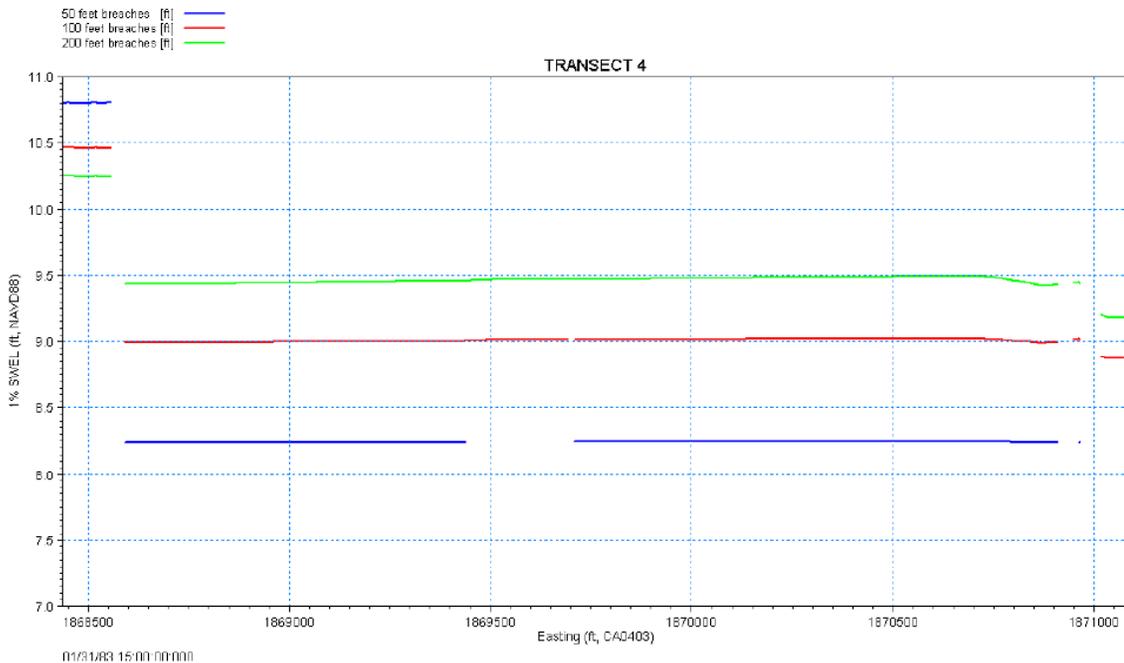


Figure 4.14 Approximate 1% SWEL along Transect 4 for the 3 breach widths. The blue line is 50 foot breach widths, red is 100 foot breach widths, and green is 200 foot breach widths.

Source: DHI 2016

### 3 Breach Width Sensitivity Testing

SRP Question: (a) Why does this analysis not meet FEMA requirements for sensitivity testing for breach width? (b) As to breach number and location, did not DHI’s analysis address the worst case, with regard to breaching, since they assumed all levees were breached?

**Response:**

See response to SRP Question 2. The sensitivity testing is not compliant with the Structural-Based Inundation Procedure. As noted in FEMA’s July 2013 report:

*“It is expected that breach width will be the most widely tested parameter during the sensitivity analysis.” page 4-17, FEMA (2013)*

and:

*“add additional breach locations to the initial locations if additional breaches can change the flood elevations or the extent of the composite floodplain significantly” page 4-15, FEMA (2013)*

Based on the documentation submitted, the sensitivity analysis is not compliant with the Structural Based Inundation Procedure described in FEMA (2013). Placing one breach in each pond segment does not necessary imply the “worst case” or the “1-percent-annual-chance flood hazard” was simulated.

Because use of the Structural-Based Inundation Approach requires less data on the levee systems and showing compliance with 44 CFR 65.10 is not required, sufficient sensitivity testing and documentation is required. The submittal must also be signed and sealed by a registered professional engineer. The documentation submitted was not signed and sealed by a registered professional engineer.

**Additional Back-up Information:**

**Response 3a.** *Why does this analysis not meet FEMA requirements for sensitivity testing for breach width?*

See general response to SRP Question 3 above.

**Response 3b.** *As to breach number and location, did not DHI’s analysis address the worst case, with regard to breaching, since they assumed all levees were breached?*

FEMA flood hazard mapping represents the 1-percent-annual-chance flood hazard. This does not necessarily correlate to the worst-case scenario, as larger flood events do occur and will occur in the future. However, based on the documentation submitted, a determination cannot be made as to whether the resultant flood hazard mapping has been reasonably identified to represent the 1-percent-annual-chance flood hazard, as outlined in the Structural-Based Inundation Approach in FEMA’s July 2013 report.

When using the Structural-Based Inundation Approach in rural settings, where levee systems protect primarily agricultural lands, simplification of the approach may be warranted to limit analysis costs that would not result in significantly different flood hazard mapping (FEMA 2013). However, in Santa Clara County, the areas inland of the pond complex are substantially developed. These areas are also low-lying, with developed areas that have subsided below mean sea level due to previous aquifer withdrawals. Some areas in the Santa Clara Valley have subsided up to 13 feet since groundwater extraction began in 1854 (Valley Water 2020). Although continued subsidence has been halted, large areas remain below mean sea level.

Due to the potential for high damage costs, both to structures and the economy, and the impacts to life safety during flood events (DWR and USACE, 2013), implementation of the Structural-Based Inundation Approach in this area (if the application of this approach can be justified) should be applied with extreme caution. A high degree of certainty is warranted to

prove that the resulting analysis and mapping represents the 1-percent-annual-chance flood event.

Because use of the Structural-Based Inundation Approach required less data on the levee systems and showing compliance with 44 CFR 65.10 is not required, the submittal must be signed and sealed by a registered professional engineer. The documentation submitted was not signed and sealed by a registered professional engineer.

#### 4 Sustained Duration of Flooding

*SRP Question: (a) Why has FEMA then assumed that the surge water level has an infinite period of time to act? Is this not very conservative? (b) Why isn't the application of 2D models with time dependent predictions by DHI a more reasonable way to estimate the flooding potential?*

##### **Response:**

FEMA's study is consistent with FEMA's guidelines and specifications. The Without Levee / Natural Valley Procedure is intended to represent a floodplain that is an ensemble of an infinite number of potential breach or failure scenarios, without the cost of analyzing an infinite number of scenarios. The procedure is not intended to demonstrate that the 1-percent-annual-chance storm surge would inundate the entire area at once during a storm event. It is a surrogate for a composite floodplain when non-levee embankments are present and alternative procedures are too costly or too complex.

In this case, the Appellant took on the task of the more costly and complex analysis procedure. The Appeal was not denied because a two-dimensional (2D) model was used. The Appeal was denied because deficiencies were noted, and the submittal was therefore not compliant with FEMA guidelines and standards.

##### **Additional Back-up Information:**

**Response 4a.** *Why has FEMA then assumed that the surge water level has an infinite period of time to act? Is this not very conservative?*

FEMA developed analysis and mapping guidelines to improve consistency in analyzing and mapping the 1-percent-annual-chance flood hazard across the United States. On the Pacific Coast, the processes that result in flood conditions do not occur concurrently. Large storm surge conditions do not necessarily occur concurrently with large waves. The response-based approach because adequate data is not available to analyze each of the processes separately and then combine them to develop the floodplain mapping. Instead, a long-term series of observations or model output that is known to include various combinations of the different processes that contribute the flood hazard is analyzed. Extreme value analysis of the long-term time series is used to calculate statistics that represent the 1-percent-annual-chance response at the shoreline.

The response-based approach is recommended for the Pacific Coast in FEMA's (2005) Pacific Guidelines over an event-based approach because it is very challenging to define a 1-percent-annual-chance "event" that results in the 1-percent-annual-chance flood hazard for any sizeable area – even an area the size of Santa Clara County.

The Appellant has produced Flood Reports after each major flood event that impacted Santa Clara County. Within these reports, the rainfall and resulting return frequencies of riverine flows are presented, along with narratives of the storm event and the resulting damage. The precipitation reported often varies greatly across Santa Clara County. In February 1998, the return frequencies reported for the various riverine flows varied 5-year in some creeks to 100-year in others. If this specific event were modeled, the resultant mapping may only reflect the 1-percent-annual-chance flood hazard in some areas and would underestimate it in other areas. A simple approach such as the Without Levee / Natural Valley Procedure is preferred to that of a more sophisticated approach that may underestimate the flood risk because of the challenges that must be overcome to demonstrate the more complicated approach reasonably represents a 1-percent-annual-chance event.

**Response to 4b.** *Why isn't the application of 2D models with time dependent predictions by DHI a more reasonable way to estimate the flooding potential?*

FEMA did not deny the Appellant's submittal on the basis that a 2D model was used. The Appellant's submittal was denied for other noted deficiencies, as noted in the appeal resolution letter. The Appellant's 2D modeling approach could be valid, with sufficient documentation, additional simulations, and more sensitivity testing. If all deficiencies are addressed to create a FEMA-compliant submittal, the Appellant may resubmit their analysis and mapping and request a Letter of Map Revision. As submitted, the Appeal could not be accepted.

## 5 Riverine/Coastal Flooding Joint Probability

*SRP Question: Doesn't this analysis support the idea that even if 100-year freshwater discharges are correlated with the 100-year surge event, that the impact of them is quite low in this area with complex topography? Is it not the case that if levees were breached, that changes in water elevation would be even lower than estimated since the river discharge would be distributed over a wider area?*

### **Response:**

The sensitivity testing noted by the SRP was completed using the regional San Francisco Bay hydrodynamic model that was updated in 2013 to represent the South Bay more accurately. The sensitivity testing was focused on assessing the impact of the riverine discharges on Bay water levels at the model output locations in the Bay, where the 54-year timeseries of Bay water levels was extracted to support the one-dimensional analysis. This sensitivity testing is not applicable to the Appellant's analysis, which used a different model and a different analysis approach.



Multiple rivers and creeks are located within the pond complex area, and the Appellant placed breaches in the pond berms to create direct flow paths between the rivers and creeks and the adjacent ponds. The freshwater riverine discharges could affect the flood elevations in the ponds and in the rivers and creeks. However, sensitivity testing of the riverine discharges was not completed.

Sensitivity testing of key factors that are likely to influence flood elevations and the extent of the 1-percent-annual-chance floodplain must be completed. It is not FEMA’s role to speculate what the impact on flood elevations would be as a result of sensitivity testing. It is the Appellant’s responsibility to justify that the analysis and mapping reasonably represent the 1-percent-annual-chance flood hazard.

## 6 WHAFIS Wave Analysis

*SRP Question: Why not use a model that is better suited to the clearly two- dimensional (2-D) nature of the wave transformation processes in this complex study area?*

### **Response:**

FEMA’s study is compliant with FEMA’s guidelines and standards. This question does not speak to any deficiency in FEMA’s analysis.

## 7 Without Levee Approach

*SRP Question: Why FEMA did not give any consideration to LAMP Policy when they chose to follow the without levee approach in their Flood Study?*

### **Response:**

FEMA’s study is compliant with FEMA’s 2005 Pacific Guidelines and July 2013 report. FEMA followed the Without Levee / Natural Valley Procedure, which is recommended in in the FEMA 2005 Pacific Guidelines and re-confirmed in the FEMA 2013 report. The San Francisco Bay Area Coastal Study was initiated in 2004. The study was placed on hold while the July 2013 report was under development. As noted on the overall schedule for the study in FEMA’s presentation, the FIRMs became effective for Contra Costa County on September 30, 2015 – the first of the 9 counties to become effective.

After careful review and consultations with the landowners responsible for the pond complexes in the South Bay, FEMA found that the pond berms were not structures that were designed for flood control. As stated in the July 2013 report:

*“If FEMA finds that a structure is not a levee designed for flood control, FEMA will not apply the new levee analysis and mapping process. This process is reserved specifically for non-accredited levees and levee systems that do not meet the requirements of 44 CFR 65.10.” page 3-3, FEMA (2013)*

Figure 3.1 from FEMA (2013) highlights the process for following the *Analysis and Mapping Procedures for Non-Accredited Levee Systems*. If a structure was not designed as a levee for flood control, item 30 notes “do not process as a levee”. Figure 3.1 further notes:

*“\*the new levee analysis and mapping approaches are not intended to change the current treatment of non-levee embankments or other structures not designed, constructed, and operated as flood control projects. The application of sound engineering methods for such structures continues to be the acceptable practice.” page 3-2, FEMA (2013)*

The Natural Valley Procedure described in FEMA’s 2013 report is consistent with the Without Levee procedure described in FEMA’s 2005 Pacific Guidelines. FEMA July 2013 report states:

*“Non-accredited levees subject to coastal flood forces will be fully intact within the storm surge model setup to determine peak storm-surge elevations seaward of the levees. In these situations, consideration will be given as to how the levee system will impact wave propagation. A steady-state condition will then be assumed landward of the levee, and the 1-percent-annual-chance WSEL will be extended landward of the non-accredited levee until it intersects the ground elevation, or the levee on the opposite side, in the case of a ring levee.” page 4-20, FEMA (2013)*

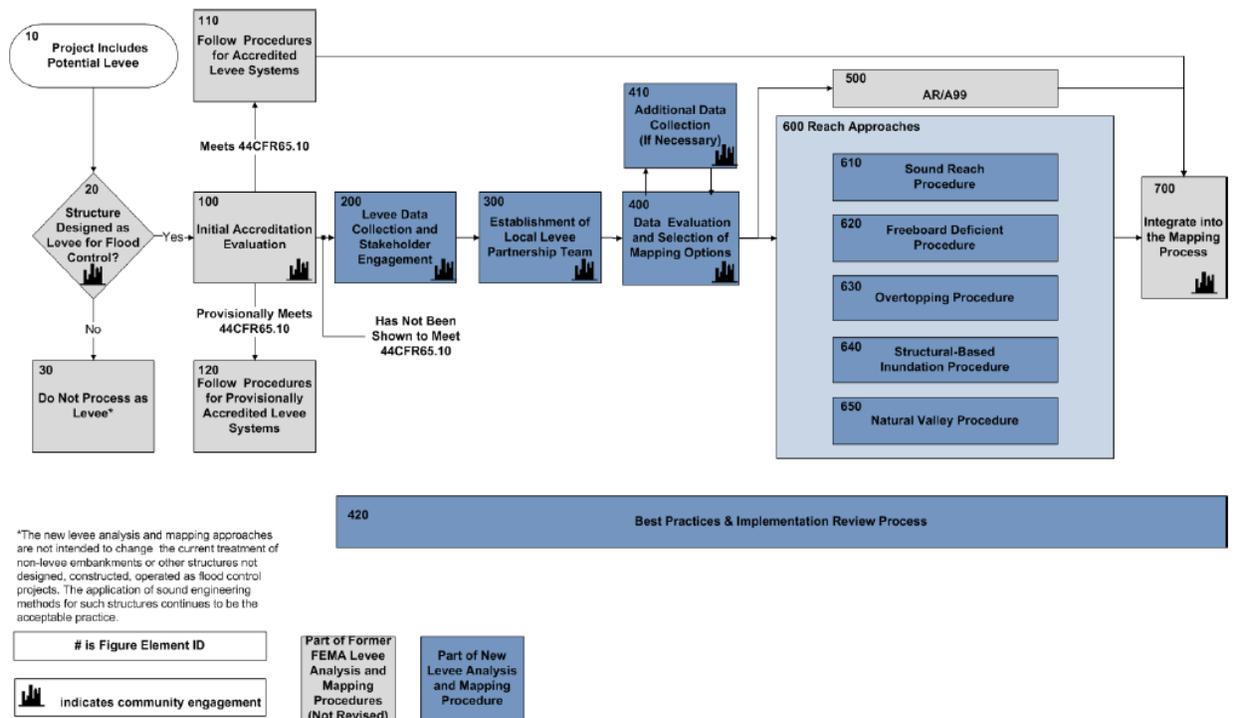


Figure 3-1. New Levee Analysis and Mapping Process

Source: FEMA 2013

## 8 Local Levee Partners Team

*SRP Question: Did FEMA form a Local Levee Partners Team to discuss the appropriate procedure under LAMP Process?*

**Response:**

As noted in the response to SRP Question 7, the pond berms were not considered levees as defined by FEMA; therefore, a Local Levee Partners Team was not established.

However, FEMA coordinated extensively with the South Bay Salt Pond Restoration Project managers and the USACE South San Francisco Bay Shoreline Study managers. At a minimum, representatives from FEMA and the other two large-scale projects met once per year during the active analysis phase and gave presentations and updates on the status of each project. Local stakeholders were invited to participate. FEMA also hosted numerous presentations, town halls, and other meetings to keep Bay Area floodplain managers and county and community officials apprised of the study process, analysis approaches, and results.

## 9 Pond Berm Assumptions

*SRP Question: What is the reason for FEMA to use with berm intact for regional analysis but failed them for the local model?*

**Response:**

Please refer to FEMA's response to SRP Question 1. The pond berms were treated consistently in all 9 Bay Area counties. FEMA's study is compliant with FEMA's guidelines and standards.

## 10 FEMA Contractor Memo

*SRP Question: Did FEMA agree with the PTS contractor, Baker-AECOM findings that the DHI's 2-D Model event-based is a superior approach to response-based approach and accepted their recommendation?*

**Response:**

FEMA does not agree with the statements excerpted from the memorandum dated June 29, 2017 from BakerAECOM to FEMA. It is FEMA's understanding that the full memorandum was not provided to the SRP for review and was not submitted by the Appellant as part of their Appeal. Therefore, the contents of the memorandum should not be considered by the Panel.

The 2D model approach can be accepted if a complete FEMA-compliant submittal is received.

**Additional Back-up Information:**

FEMA agrees with the statement made by BakerAECOM in the memorandum:

*“The pond embankments provide partial protection from direct Bay flood and wave hazards, and the ponds themselves can provide temporary flood storage. However, the effectiveness of the ponds for flood management purposes is contingent upon the active maintenance of the pond embankments which has not been clearly resolved.”*

The BakerAECOM memorandum further recommends the formation of a Technical Advisory Panel (TAP) comprised of FEMA staff, subject matter experts, local jurisdictions, the California Department of Fish and Wildlife (pond complex land owner in Alameda County), the United States Fish and Wildlife Service (pond complex land owner in Alameda, Santa Clara, and San Mateo counties), USACE, and other relevant stakeholders. The TAP was recommended to ensure that the technical approach and assumptions rely on sound engineering judgement and best technical practices. The formation of such a TAP is outside of FEMA’s control, and to FEMA’s knowledge a TAP was not created.

The following SRP questions are based on supplemental information provided by the Appellant as an attachment to their SRP Request, referred to as Attachment A: Summary of Appeal Information

**11 Levees Failing Simultaneously**

*SRP Question: Is FEMA justified in treating the levees by the ultimate conservative approach of assuming total instantaneous failure?*

**Response:**

Please refer to FEMA response to SRP Question 1.

Yes, FEMA is justified in using their approach. FEMA’s study is compliant with FEMA guidelines and standards.

FEMA applied the Without Levee / Natural Valley Procedure as documented FEMA’s 2005 Pacific Guidelines and FEMA’s 2013 report. This procedure is intended to represent a 1-percent-annual-chance floodplain that is an ensemble of an infinite number of potential breach or failure scenarios, without the cost of analyzing an infinite number of scenarios. It is not intended to represent all embankments for the entire study area simultaneously failing in response to one single event. The likelihood of that occurring is extremely unlikely. However, this is not FEMA’s underlying study assumption.

The intent of the FEMA study is not to accurately assess the pond failure mechanisms or the water levels in the pond complex. The intent is to reasonably analyze and map the 1-percent-annual-chance flood hazard, both for flood insurance rating purposes, and to support hazard mitigation efforts that can reduce the loss of life and property damage that occurs during a disaster. Santa Clara County is an area with a high coastal flood risk, as noted by DWR and USACE (2013) and the ongoing USACE South San Francisco Bay Shoreline Study. The focus of the analysis should be on reasonably representing the flood risk in the developed areas that are inland of the pond complex.

## 12 Riverine Inflows

*SRP Question: Please Provide a response to item 4.2 regarding Riverine Inflows.*

**Response 12a:** *BakerAECOM have not applied further analysis of the joint occurrence of riverine discharges and coastal water levels within the local study area*

The joint probability analysis of riverine discharges and coastal storm surge events was not completed as part of the FEMA study. FEMA agrees with the Appellant that the 54-year simulations included mean riverine discharges. This approach was justified in DHI (2011, 2013) and discussed in FEMA’s response to SRP Question 5.

As noted in FEMA’s 2005 Pacific Guidelines, it is important to assess both coastal and riverine processes, because Pacific storms often result in large rainfalls, and coastal and riverine flooding can combine to increase flood hazards near river mouths. FEMA’s goal was to reasonably represent the 1-percent-annual-chance flood condition in the urban developed areas inland of the pond complex, and these areas are subject to the combined effects of coastal and riverine flooding.

To achieve a reasonable mapped result, FEMA researched extreme storm events throughout the San Francisco Bay Area to better understand the climatology and circumstances that resulted in flooding and flood damage in nearshore coastal areas. The 16 Flood Reports<sup>2</sup> produced by the Appellant were an invaluable part of this research for the Santa Clara County study area. FEMA published some of this research in the 2016 report *Extreme Storms in San Francisco Bay – Past to Present*.

FEMA evaluated the effective riverine flood profiles in Santa Clara County and made small adjustments to the profiles to account for the higher 1-percent-annual-chance stillwater elevation. FEMA used historical accounts of flooding and reviewed Letters of Map Revision associated with levee improvements that occurred after historical floods, to create reasonable tie-ins with the effective riverine mapping. The result of this process is a reasonable

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<sup>2</sup> <https://www.valleywater.org/floodready/flood-reports>

identification of the 1-percent-annual-chance flood hazard based on all information reviewed. This process follows FEMA guidelines and standards.

**Response 12b.** *at that time FEMA had agreed to use the local 2D analysis applied by DHI, and it made more sense to apply the river discharges in the local 2D model where it would have more resolution and where it may be more critical for areas such as Coyote Creek*

FEMA had multiple meetings with SCVWD about their alternate approach. It was noted that SCVWD's approach could be submitted as an appeal and accepted if the submittal was compliant with FEMA guidelines and standards. However, the appeal has several deficiencies as noted in the appeal resolution letter.

**Response 12c.** *DHI together with ACFCD performed joint analysis of river discharge versus bay water level for Alameda Creek... The analysis demonstrated that the joint occurrence for the 1% coastal level is more closely coinciding to a 3 to 5-year river discharge.*

The Appellant references a joint probability analysis of river discharge vs. Bay water level for Alameda Creek. This analysis is not likely relevant for Santa Clara County rivers and creeks due to the differences in rainfall patterns, topography, land use, contributing watershed, and other factors. As documented in the Flood Reports produced by the Appellant<sup>2</sup>, large storms can result in varying riverine discharge return frequencies, with the February 1998 storm resulting in riverine discharges that vary from the 5-year to near the 100-year return frequencies. Based on the Flood Reports, significant flooding occurs when large storms systems occur when Bay water levels are elevated. The joint probability analysis should be reviewed against the documented historical flood events to ensure it is capturing the relevant processes.

#### **Additional Back-up Information:**

The 2005 FEMA Pacific Guideline note:

*“Before mapping the flood elevations and flood hazard zones, the Mapping Partner shall review results from the models and assessments from a common-sense viewpoint and compare them to available observed historical flood data.” page D.4.9-1, FEMA (2005)*

*“The main point to be emphasized is that the results should not be blindly accepted. There are many uncertainties and variables in coastal processes during an extreme flood and many possible adjustments to methodologies for treating such an event. The validity of any model is demonstrated by its success in reproducing recorded events. Therefore, the model results must be in basic agreement with past flooding patterns, and historical data must be used to evaluate these results.” page D.4.9-1, FEMA (2005)*

DHI (2013) states:

*“The deterministic time series or hindcast method was adopted for this study so that a response-based approach could be taken. The advantage of this approach is that the extreme water levels (or wave conditions) are determined from the nearshore response due to a variety of boundary or forcing conditions, without consideration of the statistics of the boundary conditions themselves. The events are simulated over a long period of record, including as many of the physical processes as practicable (i.e. astronomical tide, wind stress, meteorological storm surge, waves, freshwater inflows), rather than applying joint probability methods of the independent processes and recombining statistically. The method is suitable in areas where frequent broad based intense storms occur annually over wide areas so that track shifting methods, such as needed in the Monte Carlo Method (MCM), Joint Probability Method (JPM) or Empirical Simulation Technique (EST) are not necessary.” page 23, DHI (2013)*

### 13 High Ground Consideration

*SRP Question: Please respond to item No.4.3*

**Response** *(The City of Santa Clara would like the SRP to reconsider whether the Hwy 237 freeway embankment should be considered as a large land mass/high ground instead of treated as a levee.)*

The Appellant submitted a levee certification package for the Highway 237 embankment between Calabazas Creek and San Tomas Aquino Creek. The review of the submitted materials revealed that outstanding issues needed to be resolved before the Highway 237 embankments can be declared compliant with 44 CFR 65.10. These issues were documented in a memorandum dated January 17, 2019 and sent by FEMA’s PTS contractor STARR II on behalf of FEMA to Emily Zedler with SCVWD.

The request by the Appellant for the SRP to consider the Highway 237 embankment as high ground is not appropriate. The decision to certify a highway embankment as a flood protection structure is under the purview of the California Department of Transportation. A United States Department of Transportation (USDOT), Federal Highway Administration (FHWA) memorandum dated September 10, 2008 provides guidance to all local departments of transportation on the issue of highway embankments versus levees and other flood control structures (USDOT FHWA 2008). The following excerpts from the USDOT FHWA memorandum clarify their stance on this issue:

*“Recent FEMA map modernization and levee certification initiatives have revealed that for many years some highway embankments may have been either inadvertently or incorrectly designated as levees or other flood control structures. Also, some NFIP communities incorrectly assumed that these embankments provided some level of protection. Until recently, the FHWA was unaware of such assumptions.*



*Furthermore, there have been recent instances where the FEMA, other floodplain regulators, and communities (hereafter referred to as 'entities') have approached State departments of transportation (DOTs) to request DOT certification of these highway embankments as levees or flood control structures. Some entities have suggested that DOTs need to retrofit these embankments into levees and do so using Federal-aid highway funds, thus allowing for certification. Many times these entities cite significant economic hardship for the community should the DOT not take such actions.”*

*“FHWA long recognized that the highway system would cross and interact with floodplains, the system was not designed or intended to serve in a flood control role.”*

*“Staff from the FHWA's Office of Bridge Technology have carefully studied the points discussed in this memorandum and believe that certifying or otherwise designating highway embankments as levees is not an acceptable practice and should be opposed for the following reasons:*

- *Most existing highway embankments were not designed and constructed for (and thus are ill-suited to) performing as a levee or other flood control facility;*
- *In such a role, highway embankments could pose a significant and unacceptable risk to the public; and subject a DOT and FHWA to an untenable position with respect to costs, liability and damages;*
- *Certification requires conducting a thorough engineering evaluation by groups with experience in analysis and design of flood control structures and applying standards and obtaining approval of agencies responsible for flood control structures; and*
- *This situation indirectly places the FHWA into a flood control role for its Federal-aid highway program. For nearly all projects, the FHWA does not have the authority to engage in flood control activities.*

*Therefore, the FHWA discourages DOTs in certifying highway embankments as levees or allowing any such certification by any entity. Additionally, the FHWA discourages any type of retrofit efforts as DOTs and the FHWA are not in a position to assume such a role for statutory, financial, liability, and engineering reasons.*

*We recommend that you and your corresponding DOT decline any certification request from any entity that may contact you on this subject.” USDOT FHWA, 2008*



## 14 Information Not Considered

*SRP Question: Is FEMA/SCVWD going to provide these documents to the SRP and should they be considered in the Panel's deliberations?*

### **Response:**

The documents referenced by the Appellant that were submitted to FEMA outside of the Appeal period will not be provided to the SRP and they should not be considered in the Panel's deliberations.

## 15 References

DHI (2011) Regional Coastal Hazard Modeling Study for North and Central San Francisco Bay. Final Draft Report. October 2011.

DHI (2013) Regional Coastal Hazard Modeling Study for South San Francisco Bay. Final Draft Report. January 2013.

DHI (2016) South San Francisco Bay Santa Clara Valley Water District Coastal Hazards Analysis. Santa Clara County, California. Final Draft Report. April 2016.

DWR and USACE (2013) California's Flood Future, Recommendations for Managing the State's Flood risk. Final November 2013. Prepared by the State of California's Natural Resources Agency Department of Water Resources and the United States Army Corps of Engineers Floodplain Management Services Program.

FEMA (2005) Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States (January 2005)

FEMA (2013) Analysis and Mapping Procedures for Non-Accredited Levee Systems. July 2013.

FEMA (2016) Extreme Storms in San Francisco Bay – Past to Present. Prepared by AECOM, DHI, and BakerAECOM

GEI Consultants (2013). Summary Memo: Review of Existing San Francisco Bay Restoration Breaches.

SCVWD (1983) Report on Flooding and Related Damages in Santa Clara County; January 1 to April 1983. October 11, 1983.

[https://www.valleywater.org/sites/default/files/1983%20Flood%20Report\\_0.pdf](https://www.valleywater.org/sites/default/files/1983%20Flood%20Report_0.pdf)

SCVWD (1998) Report on Flooding and Related Damages in Santa Clara County; February 2-9, 1998. <https://www.valleywater.org/sites/default/files/1998%20Flood%20Report.pdf>



FEMA

USACE (2015) Appendix G. Geotechnical Engineering. South San Francisco Bay Shoreline Phase 1 Study. USACE San Francisco District. September 2015.

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<https://www.fhwa.dot.gov/engineering/hydraulics/policymemo/20080910.cfm>

Valley Water (2020) Subsidence page, <https://www.valleywater.org/your-water/where-your-water-comes-from/groundwater/subsidence>, accessed February 27, 2020.

**A.1.2. APPENDIX A.2-Santa Clara County Responses to SRP Questions**

SRP Santa Clara, CA

March 2, 2020 Oral Presentation Questions for Santa Clara, CA and FEMA Presenters.

RESPONSES TO QUESTIONS FROM Santa Clara, CA.

Provided by Valley Water on March 10, 2020. (and Update from responses provided on March 6, 2020)

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## 1. Model Mesh and Resolution near Breach Locations

**QUESTION/ASSERTION:** *How did you validate the grid system/model you selected to show that it accurately predicted the flows through these small openings? The figures showing the grid system in the vicinity of levees suggest that the resolution was inadequate to accurately predict the flows for these small-scale inlets.*

**Response:** The 100-ft wide breaches were represented in the MIKE 21 FM (Flexible Mesh) model using the Dike structures, which is a sub-grid feature of the model and, as such, independent of mesh resolution. The breach shape is assumed to be rectangular. The assumed breach extends from the top of the embankment down to the existing ground elevation at the toe of the embankment, so water reaching the structure will flow through the breach. Breaches are considered always open and were tested for hydraulic performances in other DHI studies using MIKE 21 FM.

## 2. Temporal Behavior of Flows through Breaches.

**QUESTION/ASSERTION:** *Have you investigated the impact of the duration of the flooding event on the estimated water level in the pond? If the model is applied to other top ranked storms is its filtering performance changed because of the change in duration of the flooding event?*

**Response:** The model was tested by running it for the five highest ranked storms and, as expected, it showed different performance under the different situations simulated. Even after the two largest storms (in January and December 1983) were adopted and the peak water level during each event was scaled up to the 1% SWEL, the model results showed differences: scaled Storm 2 (January 1983) produced a larger inundation area in Santa Clara County than the 1% scaled Storm 1 (December 1983) because of the different hydrographs. For this reason, the 1% scaled Storm 2 which was based on historically most severe case in South San Francisco Bay was selected as the boundary condition for the 2D evaluations.

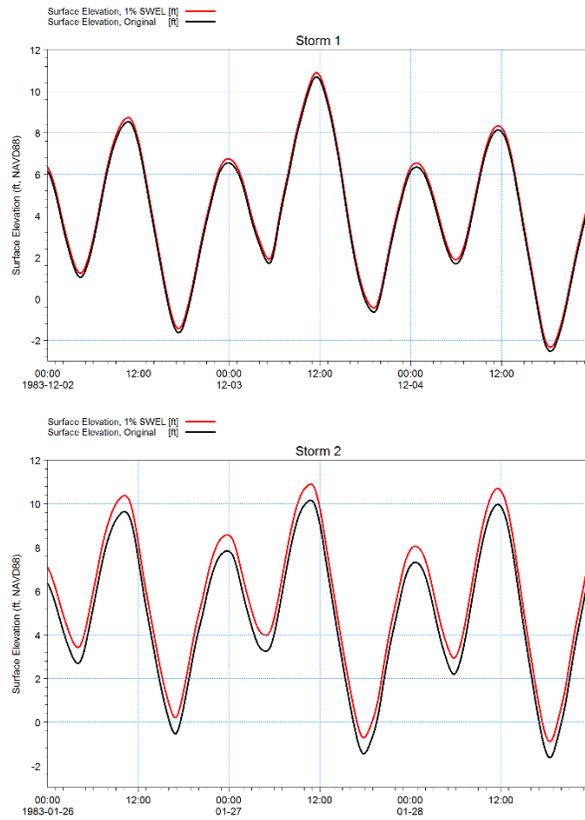
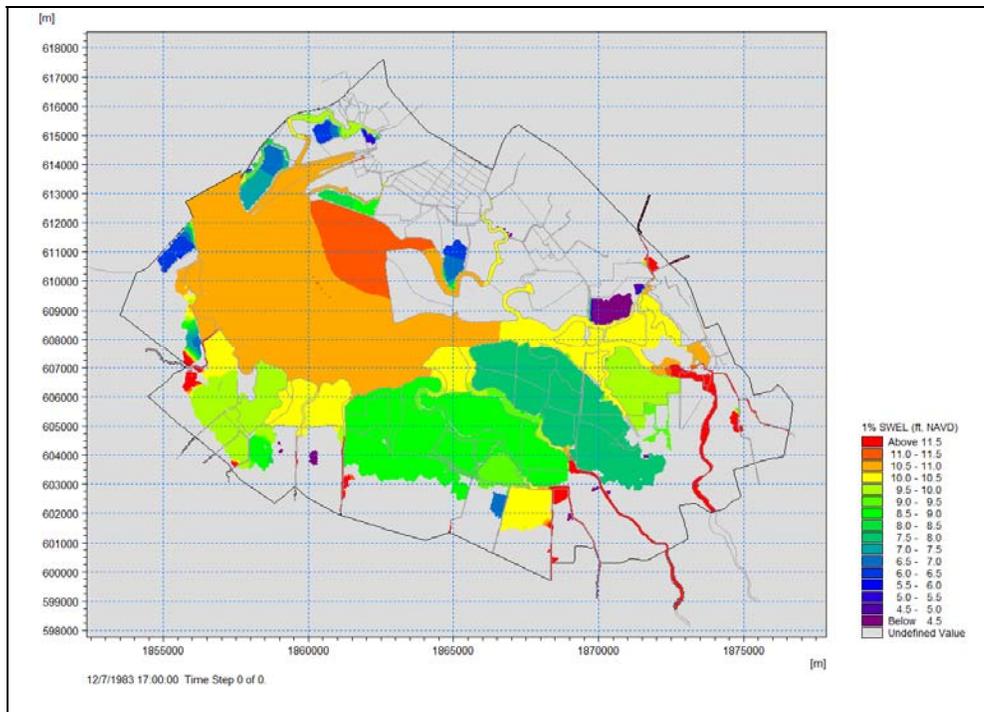


Figure Error! No text of specified style in document..1 Comparison of scaled time series for Storm 1 (upper), December 1983 and Storm 2 (lower), January 1983, at the center of the local model offshore boundary. The black line is the original time series from the regional model and the red line is scaled to the 1% level.



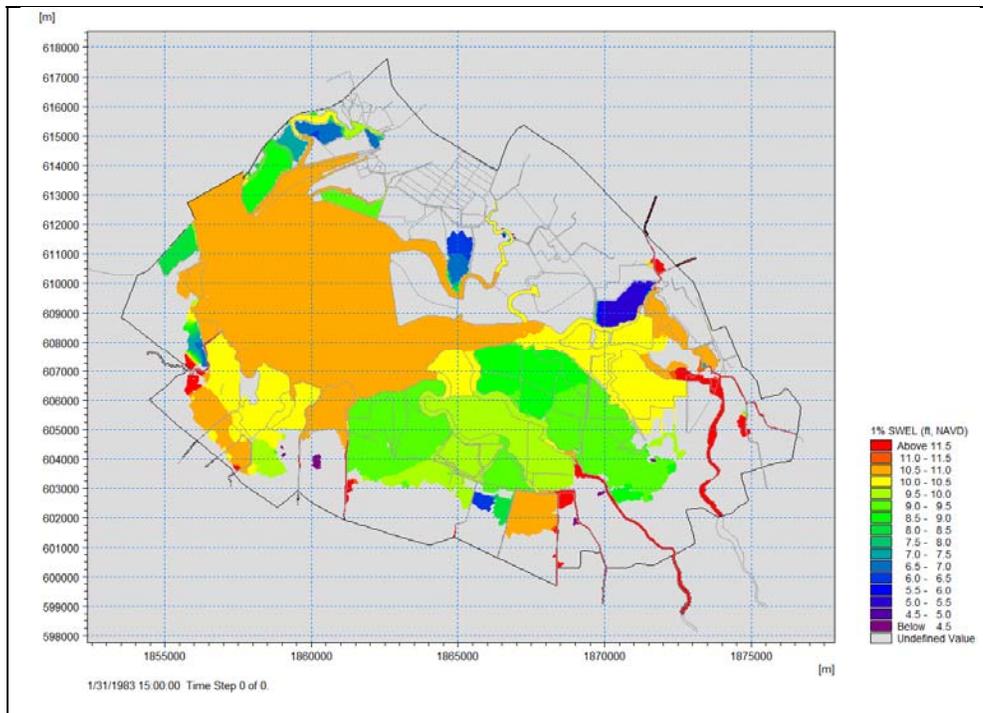


Figure Error! No text of specified style in document..2 Comparison of inundation between scaled Storm 1, December 1983 (upper) and 1% scaled Storm 2, January 1983 (lower).

### 3. Levee breach locations.

Data from the **GEI (2013) Study** support the idea that breaches of external levees are likely larger than breaches to the internal levees.

**QUESTION/ASSERTION:** *Given this observation why did you not perform a sensitivity analyses where the external levee breaches were larger than their internal/tidal fluvial counterparts?*

**Response:** Based on GEI report the current average breach width for all external levees is 125ft and only 66ft for internal levees. The GEI report also indicates that it will take decades for these breaches to reach their upper limits. Therefore, we feel strongly that our assumption of 117 simultaneous 100-ft wide breaches for every side of the coastal berms was very conservative.

**What data or conceptual framework did you develop to support the case for all levees breaching to 100-ft length? Is there any historical support for this? Any theoretical probability projection?**

**Response:** Considering that the breaches are assumed to be always open, and thus breach development time is not relevant, the following summarizes the selection process for selecting a breach width:

1. At the time of implementing the methodology, the draft LAMP guidance for partial failure, for clay, recommended 100 feet widths. GEI surveys (GEI, 2013) indicate the materials are clay.

2. 100-ft is consistent with planned managed breach widths for restoration studies.
3. Statistics from GEI table below include breach widths that are independent of how long time the breach has been open, and whether it is maintained and allowed to continue to widen. Since we were modelling a combination of external, but much more of the tidal/fluvial and internal levee breaches in south Bay, we used the average of all 3 types in GEI's table. The average current breach widths are 125 ft for external, 86ft for Tidal Fluvial and 66 ft for internal. Average of all 3 is about 92 ft and the LAMP Guidance was 100 ft for non-certifiable levees so we used the higher one of the two.
4. Plots from the GEI Technical Memorandum, shown in **Error! Reference source not found.**, **Error! Reference source not found.** and **Error! Reference source not found.** of DHI's report for External, Internal and Tidal Fluvial breaches, respectively shows that breach width progression is slow over very long time scales and stops at around 100 ft (commensurate with tidal prism)
5. Statistically, an event that can cause simultaneous failures of all the levees close to their maximum potential breach width is a much rarer event than a 1% chance event. Therefore, we feel strongly that our assumption meets or exceeds a reasonable conservative bench mark for coastal hazard mapping.

<i>Breach Type Category</i>	<i>Average Current Breach Width (feet)</i>	<i>Minimum Current Breach Width (feet)</i>	<i>Maximum Current Breach Width (feet)</i>
<i>External</i>	<i>125</i>	<i>100</i>	<i>175</i>
<i>Tidal-Fluvial</i>	<i>86</i>	<i>50</i>	<i>150</i>
<i>Internal</i>	<i>66</i>	<i>25</i>	<i>160</i>

**QUESTION/ASSERTION:** *Has DHI or others performed any simulations that investigate the impact of uncertainty in the topography or any other parameter on the predicted flooding of the South Bay Study Area?*

**Response:** We used the best available information existing at the time of the study to define the bed elevations in the model bathymetry, including the 2-meter USACE 2012 South Bay DEM (which in turn makes use of data from six sources), USGS 2010 LiDAR and 2006 Santa Clara County LiDAR.

While we did not perform any simulations to investigate the impact of uncertainty in the topography or any other parameter on the predicted flooding of the South Bay Area, it is our experience that it is difficult (if not impossible) to calibrate a hydrodynamic model using a wrong bathymetry. As shown by Figures 5.16 through 5.21 in DHI's report, the hydrodynamic model results agreed well with water levels measured in the South Bay study area.

Additionally the topographic and bathymetric data used in DHI study was also used by Baker/AECOM studies and can be subjected to the same questions.

**4. Request a point-by-point response to the FEMA letter of 21 June 2019 (along with data/info locations in SC data submittal) where FEMA letter is either:**

- a. INCORRECT (point out written justification in package already submitted); OR**
- b. INAPPROPRIATE (based on FEMA guidelines)**

**1. SCVWD did not provide enough evidence to prove that analyses and results in FEMA's study are scientifically or technically incorrect (44 CFR Part 67):**

FEMA did not have specific guidelines which applied to the unique South Bay environment. For this reason, FEMA funded the original CTP study for Alameda County, which used methodology similar to the DHI study and was intended to serve as the basis for the updated coastal floodplain mapping there. Valley Water's position is that an appropriate method for mapping the coastal floodplain for the South Bay should be based on physical characteristics of the South Bay and not a "one size fits all" approach. With considerations to these physical realities, we believe that the application of the 2-D method employed by DHI is technically accurate because it considers the presence of the vast network of historic salt ponds. FEMA/Baker AECOM application of 1-D ignores this extremely important feature and therefore should not be used in the South Bay.

**2. USFWS does not have adequate maintenance plans for the embankments. Furthermore, ponds will not remain as fixed features because of SBSRP.** Valley Water asserts the following:

- a. The DHI approach assumes that 117 breaches, each 100 ft wide, have occurred. These breaches are fixed throughout the entire simulation. This assumption is also consistent with the South Bay Salt Ponds Restoration future Projects concepts. However, it should be noted that under existing conditions most of these ponds do not have any breaches.
- b. Additionally, maintenance plan for these pond berms would be to prevent the modeled breaches from forming, and/or to maintain the breached system below or at the level of the modeled breaches (i.e. not allow breaches to widen after reaching widths of 100 ft).
- c. The USFWS current position regarding coastal levees maintenances is published in a letter to FEMA and it states that the USFWS recognizes the flood risks associated with the coastal levee failures and will perform maintenance activities on as needed bases. The letter also states that USFWS will not allow the coastal flood hazard condition to worsen above the existing condition. We believe that the USFWS position is more than adequate for the assumption used within the DHI study.
- d. Meanwhile, Valley Water is still working with Fish and Wildlife Services (USFWS) on a maintenance protocol. We recently had a meeting with USFWS on March 3,

2020 in which they laid out plans for maintaining the ponds. Berms around the AB1/AB2, A2E, A3W and A3N complex will be raised to meet 13 ft NAVD88 elevation in areas that are currently below 12 ft NAVD88 and that work is planned to start later this year. Maintenance work there is projected to last about 20 years. Current efforts to maintain the shoreline berm along the land-side part of A8S (by building a low slope, ecotone berm there through adding fill) will be continued.

3. **100-ft wide breaches in model, not consistent with LAMP. Breach width not supported by GIE soil analyses. Sensitivity analyses to support breach width, location and number (FEMA 2019) not submitted:** See the response above to #3, to address the comment about the use of 100 ft wide breaches. Valley Water disagrees that 100 ft wide breaches are insufficiently wide based on the GEI report, for the South Bay locations. Sensitivity analyses to breach width are included in DHI’s report of April 2016. A detailed response was provided in the SRP Request form.
  
4. **SCVWD did not provide demonstration that the statistical probability of the flood elevations and durations for the two selected storms events sufficiently characterized a 1% annual chance storm event:** The main point of contention is the use of an event-based approach versus a response-based methodology. Although we are not allowed to introduce new information, even FEMA has changed its mind on this item. Alameda County used a similar approach in their appeal. During the back and forth between FEMA and Alameda County, It was proven to FEMA that an event based approach is more conservative than a response based approach. Baker AECOM reviewer has provided comments regarding this subject directly to FEMA. The procedure was described in detail in Section 3, Item 3 of DHI’s Report, which also includes a detailed discussion.
  
5. **Justification for use of 5-year max discharge in 2D modeling not submitted. Sensitivity analysis to riverine discharges did not include breaches.** FEMA’s mapping of the 100-year Coastal floodplain did not include significant flows from creeks. Except for inflows from the Sacramento River, for which a 54 year flow record was used, all inflows from the remaining 20 creeks were set to daily average values. The table below compares the flows used in the regional model with the 5 year recurrence interval peak flows for the South Bay.

Creek	Flow in Regional Model (cfs)	Peak Flow in DHI South Bay Model (5 Year Event Peak)
San Francisquito Creek	17	3425
Stevens Creek	13	3799
San Tomas Aquino Creek	24	3775
Guadalupe River	87	6466
Coyote Creek	48	7172

Typically, FEMA uses separate analyses for 1% coastal and riverine floodplains, overlaps them, and takes the worst case. In this case, we have mapped the 1% coastal floodplain with 5- year flows and determined the tie in points with the effective 1% riverine

floodplain. Since coastal and riverine events are generally independent, use of return periods larger than 5 years cannot be justified.

**6. Wave inputs at outboard side of transects reduced at start of transect. Appropriate input should be used to evaluate runup and overtopping. WHAFIS card errors:**

- Regarding WHAFIS card issues, it is recognized that there could be some issues or inconsistencies. We have not seen the full review of these data and would need more specifics. Admittedly, DHI used different card designations than BakerAECOM did in southern Alameda County. For example, DHI often used OF offshore of the outboard shoreline, where BakerAECOM did not ever use OF cards. During the ACFCD comment/response process, DHI updated these cards, but also were able to show that it had no end effect on the actual wave heights. Again, these changes were made after SCVWD submitted their appeal data, so there was no opportunity to update these for SCVWD.
- Comments regarding low wave heights designated at the WHAFIS boundaries. For some transects there were lengthy outboard high elevation marsh areas, and waves were significantly attenuated. In other cases, it was simply that the 1%WCE minus the 1%SWEL was effectively equal to zero for the first probability pairing, so the wave height is set to zero.

**7. WHAFIS results not supporting mapped flood zones. BFEs with > 3 ft waves above SWEL mapped as AE instead of VE zones:** If there are errors in the floodplain map zoning designation a simple and easy fix is to change the designations before maps are published.

Questions regarding whether certain VE zone designations were appropriate compared to using an AE designation: some of these are close calls, but DHI did not always use only a 3-foot wave criteria, but also had a criteria if a wave greater than 1-foot existed, then wave runup would be assessed. Quoting from Baker/AECOM's report for Marin County, which we often used as a guide, *"The 1-foot criterion was chosen as a reasonable minimum wave height that may result in hazardous wave runup flood conditions"*. This criterion sometimes led to an increase in TWL to justify the VE designation, both for the outboard and inland wave runup calculations.

**5. Is there any evidence that FEMA has violated the guidelines provided in their "Coastal Flood Hazard Analysis and Mapping for the Pacific Coast..."?**

**Response:** The Coastal Flood Hazard Analysis and Mapping Guideline for the Pacific Coast of the US, simply instruct that non-accredited structures should be removed at once and not be given any credit for protecting against coastal flooding. The procedure was developed for open coast and not for sheltered water bodies such as San Francisco Bay. FEMA did not follow the open coast guideline for the San Francisco Bay Regional Model and maintained all the coastal levees intact. FEMA recognized the difference and the two dimensionality of the problem. Switching back to the guideline and using a 1D open coast approach for the local hazard mapping in South San Francisco Bay is not consistent with FEMA original assumptions within its own regional model and therefore technically inaccurate.

**6. Is there any evidence that FEMA has not followed the procedural aspects of their “Non Accredited Levees procedures” (i.e. LAMP publications)?**

**Response:** The LAMP procedure was developed to provide a lower but reasonable level of flood protection credit to non-accredited levees. The FEMA study extends the 1% still water level from the Bay many miles inland and does not provide the LAMP intended flood reduction credit to a vast network of coastal levees except for the wave reduction.

Additionally, FEMA ignored the natural tide cycles of the highs and lows and assumed the 1% tide to remain constant indefinitely. This assumption also ignores the time variability of inflow hydrographs that is allowed within LAMP guideline for riverine systems.

**7. What is the Santa Clara justification for the "earthen embanked ponds" to be called "levees" in accord with the FEMA and USACE definitions of "levees"?**

**Response:** We agree that the term “embankment” is a better denomination than “levee” for the structures surrounding the ponds. The DHI modeling results demonstrate that the pond berms provide coastal flood protection, even with breaching. Valley water does not request that these dikes be called levees.

## **A.2. APPENDIX B-FEMA PRESENTATION TO SRP**



# Scientific Resolution Panel Santa Clara County, CA

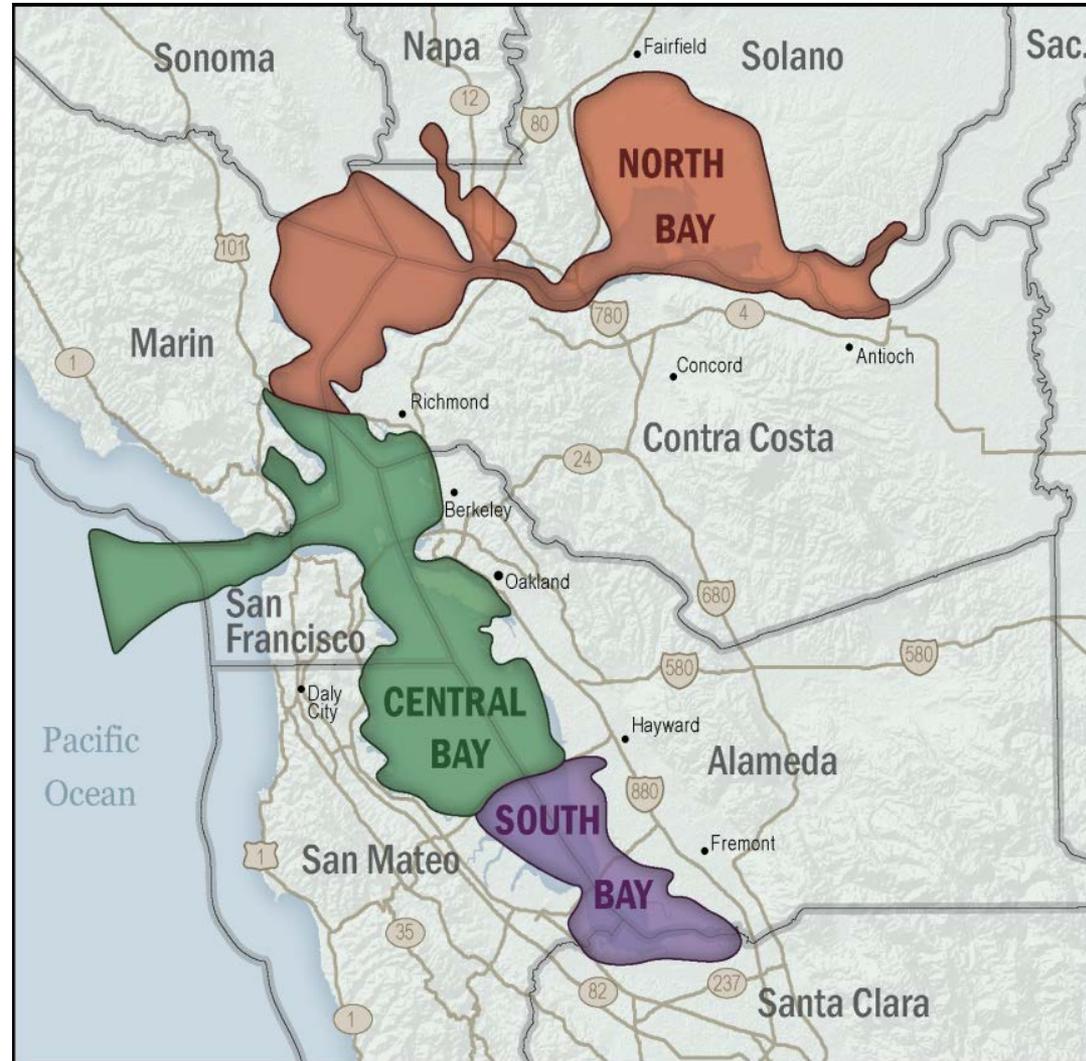
March 2, 2020

# Presentation Overview

- **History of the San Francisco Bay Area Coastal Study**
- **Summary of the Appellant's Riverine Appeal and Resolution**
- **Summary of the Appellant's Coastal Appeal and Resolution**
  - Overview of the Santa Clara County Shoreline and Pond Complex
  - Overview of the San Francisco Bay Coastal Appeal and Resolution
  - Appeal Findings 1 – 7
  - Summary of Appeal Findings

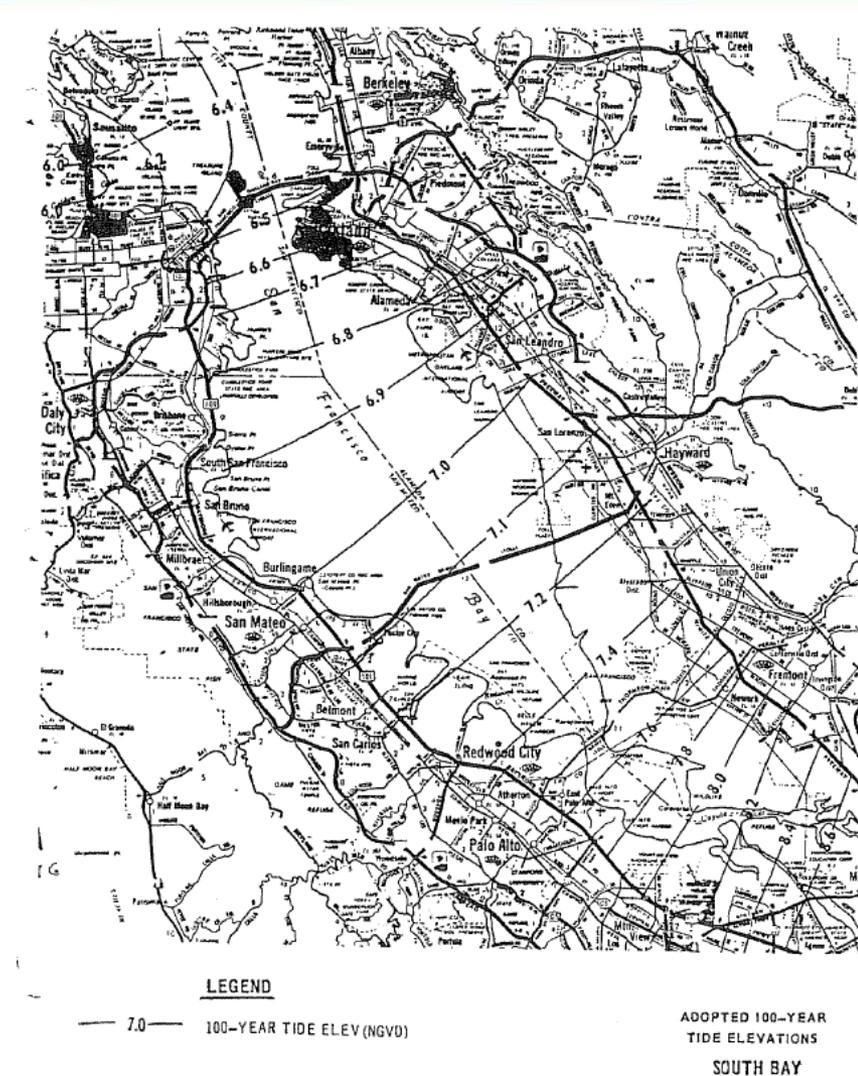
# San Francisco Bay Area Coastal Study

- **Santa Clara County is part of a larger study of the entire San Francisco Bay**
  - ✓ 2010 USGS/NOAA LiDAR data
  - ✓ Regional modeling – tides, swell, waves
  - ✓ Overland wave propagation
  - ✓ Wave runup
  - ✓ Wave overtopping



# Effective Coastal Hazards

- Based on 1984 USACE Tidal Stage vs. Frequency Study
- Analysis of all available bay tide gages
- No wave hazard analysis



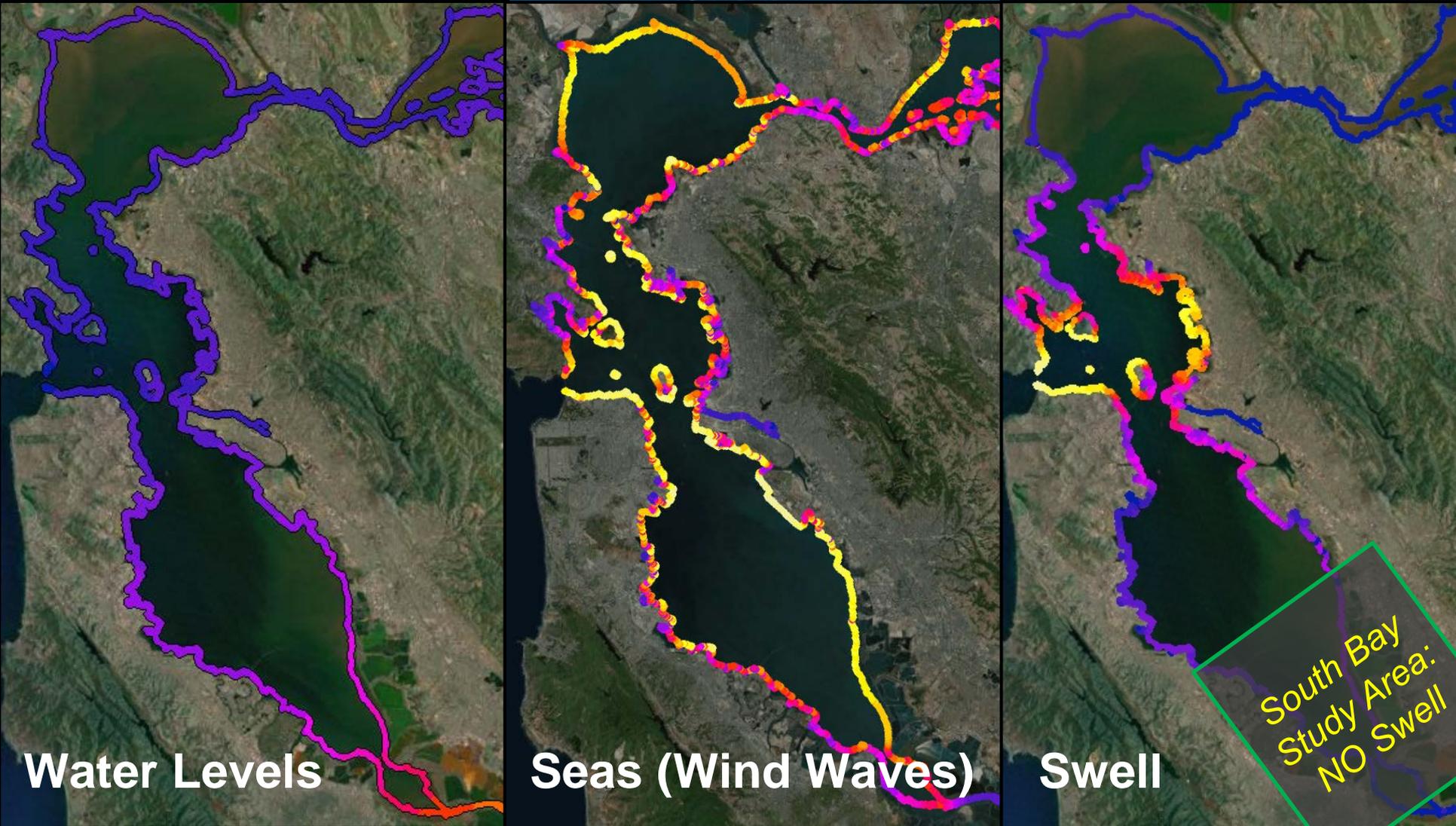
# Phase 1 (2004 – 2006)

- **Identified topographic, bathymetric, tide, wind, wave, and other required data**
- **Conducted field reconnaissance**
- **Developed technical approach for assessing and mapping San Francisco Bay coastal flood hazards**
- **Reviewed by the Technical Working Group developing FEMA's Coastal Flooding Guidelines**

# Phase 2 (2008 – 2011)

- **Regional hydrodynamic and wave modeling**
  - Tides
  - Wind-driven waves
  - Ocean-driven swell (long-period waves)
  - Major riverine inputs
- **Calibrated and validated to 13 storm events (periods with elevated Bay water levels)**
- **Independent Peer Review by USACE and multiple contractors**

# Regional Modeling



# Phase 3 (2009 – 2017)

- **Detailed coastal analysis and mapping on a county-by-county basis for the 9 Bay Area counties**
  - Field reconnaissance
  - Extreme value analysis
  - Overland wave propagation
  - Wave run-up
  - Evaluation of accredited structures
- **Extensive stakeholder coordination**
- **Independent Peer Review for technical appropriateness and compliance with FEMA guidelines and standards by two or three contractors per county**
- **All QA/QC documentation was included within each FEMA submittal (e.g., coastal analysis and mapping reviewed and submitted separately)**

# Overall BAC Schedule Snapshot

## Effective:

- Contra Costa 9/30/2015
- Sonoma 10/2/2015
- Marin 3/16/2016
- Napa 8/3/2016
- Solano 8/3/2016
- Northern Alameda 12/21/2018
- San Mateo 4/5/2019

## Letter of Final Determination:

- San Francisco 8/12/2020

## Appeal Resolution:

- Santa Clara

## Comment Resolution:

- Southern Alameda



# Santa Clara County Schedule

Task	End Date
Coastal Analysis	April 2014
Floodplain Mapping	September 2014
Flood Risk Review Meeting	September 23, 2014
Preliminary FIRMs	July 8, 2015
Preliminary FIRM/CCO Meeting	September 30, 2015
Appeal Received	June 6 and 8, 2016
Appeal Acknowledgment Letter	June 13, 2016
Appeal Period End	June 15, 2016
Appeal Resolution Letter	June 21, 2019
SRP Panel Convened	February 10, 2020

# Appeal Overview

## *Riverine Levees*

### Riverine Levees

- **San Tomas Aquino Creek east bank north levee**
- **California State Route 237 embankments**
- **The Appellant sought to demonstrate compliance of these structures with Title 44, Chapter 1, Section 65.10 of the Code of Federal Regulations (44 CFR 65.10) to revise the preliminary mapping behind them**



# Appeal Resolution – Appeal Denied

## *Riverine Levees*

- 1. The Appellant did not present any errors in FEMA’s study**
  - 44 CFR 67.6 states that the “sole basis of appeal...shall be the possession of knowledge or information indicating that elevations proposed by FEMA are scientifically or technically incorrect”
- 2. Compliance with 44 CFR 65.10 was not demonstrated for either riverine levee structure. Deficiencies were documented in the memorandum sent by FEMA’s contractor STARR II to Valley Water on January 17, 2019.**

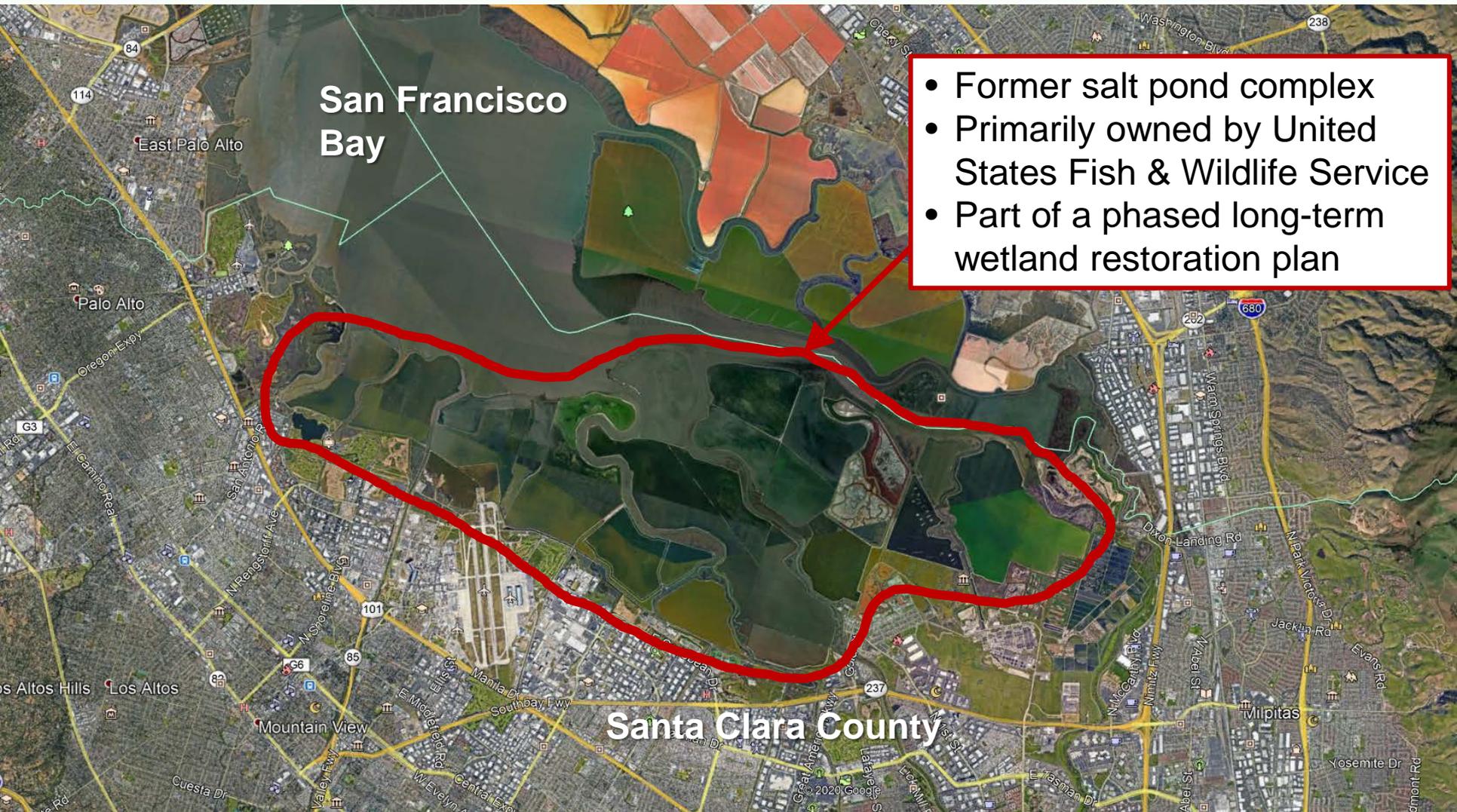
# Appeal Overview

## *San Francisco Bay Coastline*

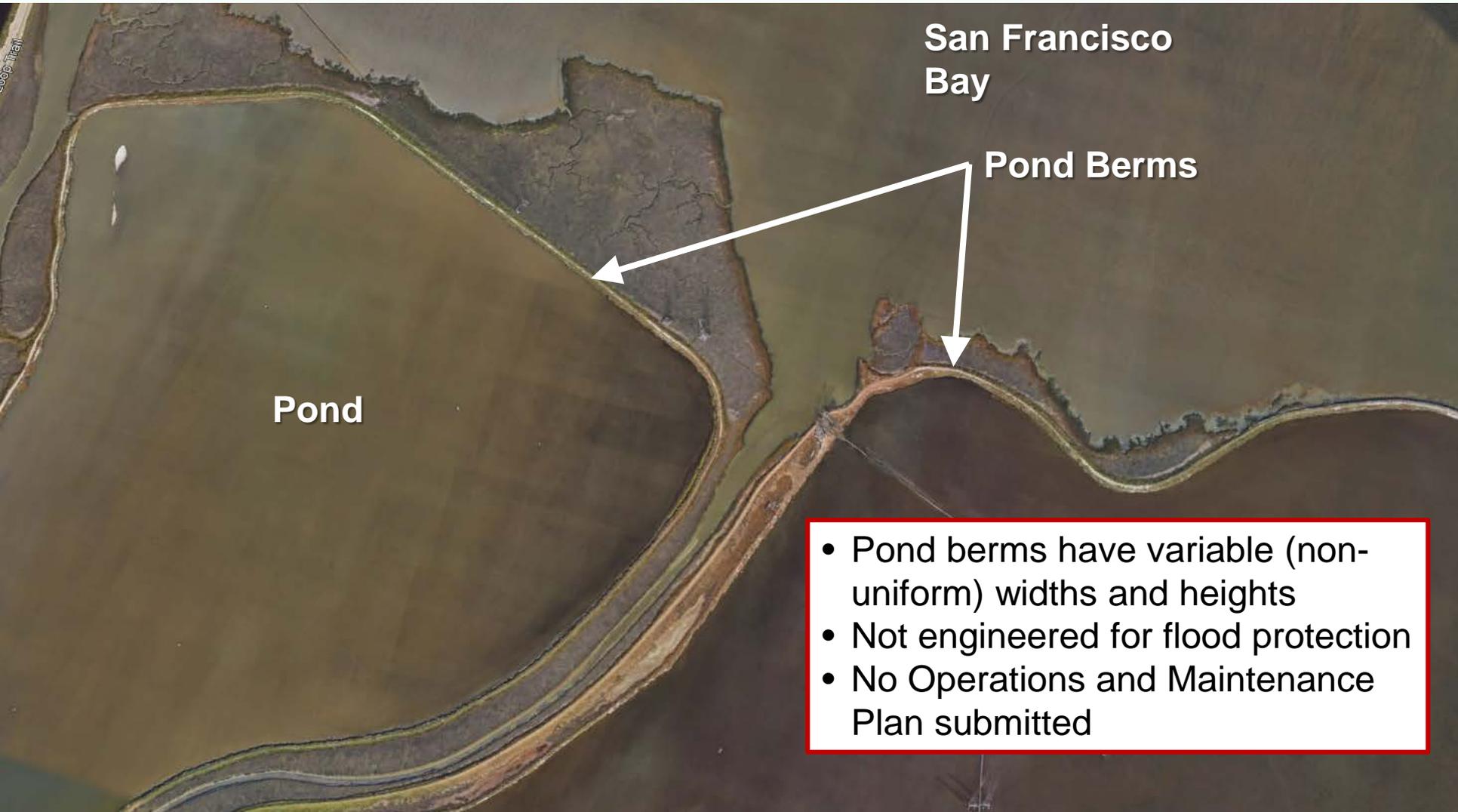
### San Francisco Bay Coastline

- **The Appellant submitted an independent coastal flood hazard study of the Santa Clara County shoreline and former salt ponds, with 2D model simulations to represent how the 1-percent-annual-chance event propagates through the pond complex**
- **Asserts the FEMA SFHAs and BFEs are scientifically incorrect**
- **States the steady-state (static) FEMA approach is overly simplistic and overstates the SFHA boundaries, BFEs, and base flood depths**
- **States the FEMA study lacks detailed, site-specific evaluations of the inland tidal channels and floodplains**

# San Francisco Bay Coastline Pond Complex



# San Francisco Bay Coastline Pond Berms



- Pond berms have variable (non-uniform) widths and heights
- Not engineered for flood protection
- No Operations and Maintenance Plan submitted

# San Francisco Bay Coastline Pond Berms



- **Pond berms vary in width, elevation, vegetation growth**
- **Restoration efforts will breach and lower pond berms to support tidal wetland restoration**

# San Francisco Bay Coastline Pond Water Control Structures



- Tide gates and culverts currently control Bay water circulation
- Condition of berms varies greatly

# Appeal Resolution – Appeal Denied

## *San Francisco Bay Coastline*

- 1. The Appellant did not present any errors in FEMA's study**
- 2. Although the Appellant's approach was generally consistent with FEMA's July 2013 report *Analysis and Mapping Procedures for Non-Accredited Levee Systems*, the submittal was not compliant with this report**
- 3. The pond berm breaching approach was not consistent with FEMA's July 2013 report *Analysis and Mapping Procedures for Non-Accredited Levee Systems***

# Appeal Resolution – Appeal Denied

## *San Francisco Bay Coastline*

- 4. The selected synthetic storm event was not documented to be representative of the 1-percent-annual-chance event**
- 5. No justification was provided for pairing 5-year riverine flows with the synthetic storm surge “design storm” hydrograph**
- 6. There were errors and inconsistencies in the Wave Height Analysis for Flood Insurance Studies (WHAFIS) modeling**
- 7. The translation of the WHAFIS analysis to floodplain mapping could not be reproduced and is inconsistent with FEMA’s mapping guidelines**

# San Francisco Bay Coastline Finding #1

## **The Appellant did not present any errors in FEMA's study**

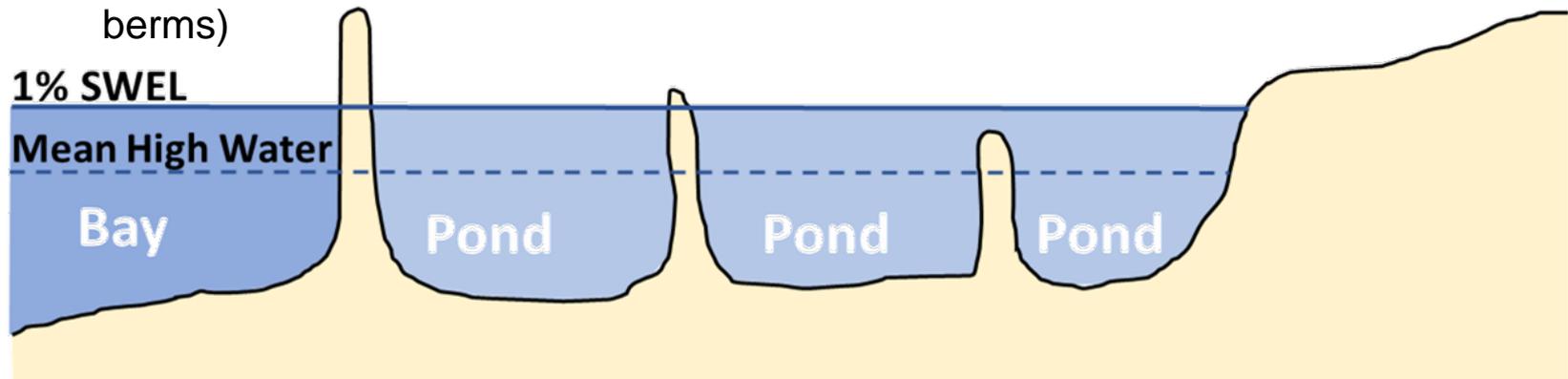
- **44 CFR 67.6 states that the “sole basis of appeal...shall be the possession of knowledge or information indicating that elevations proposed by FEMA are scientifically or technically incorrect”**
- **Appellant asserted that FEMA's approach was generalized and overstated hazards but did not provide any evidence that FEMA's approach is scientifically or technically incorrect**
- **FEMA's approach is consistent with FEMA guidelines and standards**

# San Francisco Bay Coastline

## Finding #2

### FEMA study approach is consistent with FEMA's July 2013 report *Analysis and Mapping Procedures for Non-Accredited Levee Systems*

- Pond berms were not engineered for flood protection
- Existing tidal channels and creeks adjacent to the ponds do not have FEMA-accredited levee systems or structures
- FEMA applied "Natural Valley Approach" from the FEMA 2013 report
  - 1-percent-annual-chance stillwater elevations (SWEL) were extended behind (i.e., landward of) non-accredited structures and non-levee embankments (e.g., pond berms)





# San Francisco Bay Coastline Finding #2

## **Appellant's submittal is not compliant with FEMA's July 2013 report *Analysis and Mapping Procedures for Non-Accredited Levee Systems***

- **A registered professional engineer must sign and seal all engineered data developed for each procedure in FEMA's 2013 report (page iii, page 4-14)**
- **If FEMA finds that a structure is not a levee designed for flood control, FEMA will not apply the new levee analysis and mapping process (page 3-3)**
- **While FEMA recognizes that non-levee embankments may in certain situations have a mitigating effect on flooding, if a structure is not designed and operated specifically to provide flood control it is not a levee and therefore is not addressed using the new process (page 3-3)**



# San Francisco Bay Coastline Finding #2

**Appellant's submittal did not support defining the pond berms as levees as outlined in 44 CFR 65.10**

- **Pond berms (e.g., non-levee embankments) were not designed for flood protection purposes**
- **Structural design standards not submitted**
- **Operations and maintenance plans not submitted**
- **Inspection reports not submitted**

# San Francisco Bay Coastline

## Finding #2

**Appellant's submittal did not meet the requirements of the Structural-Based Inundation Procedure described in FEMA's July 2013 report *Analysis and Mapping Procedures for Non-Accredited Levee Systems***

- **Used for levee systems that have reaches with either known structural deficiencies or a lack of data to support one of the other procedures**
- **Procedure relies on modeling levee breaches along a levee reach**
- **Differs from an accredited levee system because procedure only requires that all items available be signed and sealed by a registered professional engineer**
- **The only mandatory data requirement is an accurate depiction of the top-of-levee and toe-of-levee elevations**
- **In some cases, FEMA will require operation and maintenance plans, structural design standards, and inspection reports that meet 44 CFR 65.10**



# San Francisco Bay Coastline Finding #2

**Appellant's submittal did not meet the requirements of the Structural-Based Inundation Procedure described in FEMA's July 2013 report *Analysis and Mapping Procedures for Non-Accredited Levee Systems***

- **Mandatory accurate top-of-levee and toe-of-levee elevations not submitted** (page 4-14 of FEMA's July 2013 report)
- **Submittal must be signed and sealed by a registered professional engineer** (page iii and page 4-14 of FEMA's July 2013 report)



# San Francisco Bay Coastline Finding #2

## **The long-term ad hoc flood protection provided by the pond complex is planned to change over time**

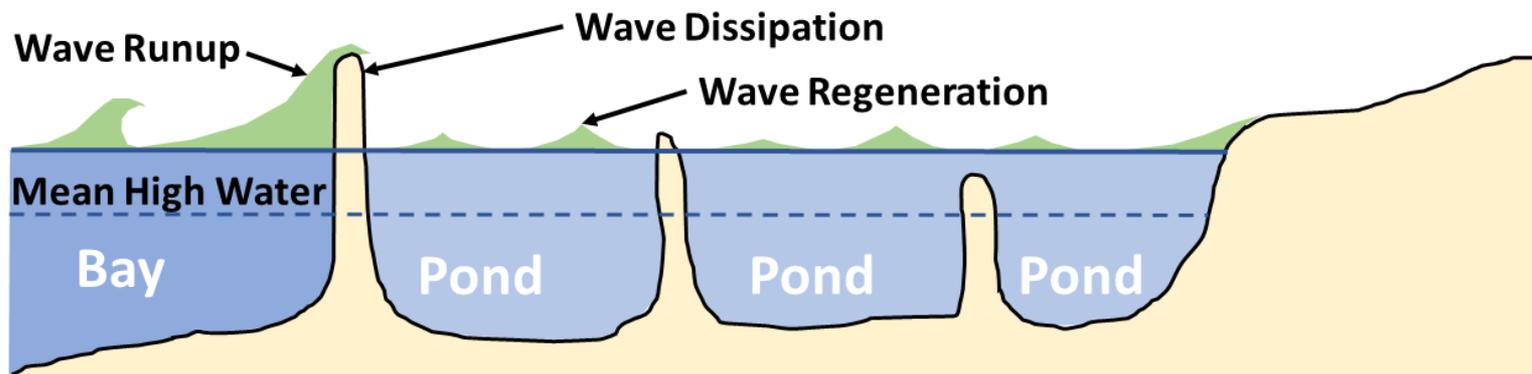
- Appellant's analysis assumes the pond berms and pond complex will remain and function "as is" in perpetuity
- The pond complex is part of the South Bay Salt Pond Restoration Project and the USACE South San Francisco Bay Shoreline Project
- USFWS (the owner) is breaching and lowering pond berms to support tidal wetland restoration
- USACE (with local sponsors) determined that pond restoration efforts will increase inland flood risks, requiring new inland coastal levees and levee improvements before some restoration efforts can begin
- \$177.2 million in Federal funding was authorized under the USACE Fiscal Year 2018 Disaster Supplemental Appropriations Bill to complete project design and begin construction of a new 4-mile long coastal levee with accompanying pond and ecosystem restoration

# San Francisco Bay Coastline

## Finding #3

**Appellant asserts that FEMA ignores the ponds and pond berms and does not account for the ad-hoc flood protection they provide**

- FEMA used the Natural Valley approach (appropriate for non-levee embankments, see Finding #2)
- Assumes pond berms will not provide flood protection during a 1-percent-annual-chance event (i.e., the pond berms would fail or be overtopped by floodwaters)
- Assumes pond berms will dissipate wave hazards; pond berms are included in the one-dimensional wave modeling, and wave regeneration is generally interrupted at the pond berms



# San Francisco Bay Coastline

## Finding #3

### **Appellant used Structural-Based Inundation Procedure (see Finding #2)**

- **Select initial breach locations for each levee reach, one representing a downstream breach location and one an upstream location**
- **Determine the breach hydrograph associated with the 1-percent-annual-chance flood as though it occurs independently and combine the results into a composite SFHA delineation**
- **Use judgment, through examination of the terrain landward of the levee and/or preliminary modeling results, on whether the selected breach locations result in a reasonable identification of the flood hazard. The flood hazard will be considered reasonably identified when all potential storage areas and flow paths that can be reached by breach flows reflect the potential flood hazard.**
- **Add additional breach locations to the initial locations if additional breaches can change the flood elevations or the extent of the composite floodplain significantly**

# San Francisco Bay Coastline Finding #3

## Breach size, number, and location are not consistent with the Structural-Based Inundation Procedure

- **FEMA's July 2013 report recommends:**
  - Breach width estimation should consider levee embankment height, levee material, crest width, overtopping, longitudinal river velocity, area protected by levee, and duration of river stage
  - Method to estimate breach width will be based on sound engineering judgment, adjusted by comparing to historical documented levee breaches
  - *Minimum* breach width of 100 feet for clay and 500 feet for sand
- **Appellant applied 100-foot wide breach widths in each pond berm segment**
- **GEI (2013) notes that pond berms are consolidated clay and silty clay material; USACE (2015) notes that berm crests range from loose silt to loose soil with high organic content (i.e., high potential for erodibility)**

*USACE (2015). Geotechnical Field Assessment of the San Francisco South Bay Dike System*

*GEI Consultants (2013). Summary Memo: Review of Existing San Francisco Bay Restoration Breaches*

# San Francisco Bay Coastline Finding #3

## Average Current Breach Widths (GEI, 2013)

Breach Type Category	Number of Breaches Reviewed	Average Current Breach Width (ft)	Minimum Current Breach Width (ft)	Maximum Current Breach Width (ft)
External	15	195	45	675
Tidal-Fluvial	19	101	45	240
Internal	18	74	25	160
Armored	8	161	50	525
Unplanned	2	115	50	180

- **External (Bayfront) breaches could be significantly larger than internal pond berm breaches**
- **Most breaches are planned (man-made) for restoration purposes**

# San Francisco Bay Coastline

## Finding #3

**Breach size, number, and location are not consistent with Structural-Based Inundation Procedure described in FEMA's July 2013 report *Analysis and Mapping Procedures for Non-Accredited Levee Systems***

- **SCVWD (2015) noted that based on GEI report (2013), breach widths for external levees ranged from 125 feet to 128 feet (focusing on breach widths in the South Bay)**
- **SCVWD (2015) noted that sensitivity analysis of 100-foot and 200-foot breaches produced water level differences of 0.5 feet or less**

*Letter dated May 14, 2015 from Dr. Liang Lee (Deputy Operating Officer, Santa Clara Valley Water District) to Juliette Hayes (Risk Analysis Branch Chief, FEMA Region IX) regarding FEMA California Coastal Analysis and Mapping Project/Bay Area Coastal Study: Coastal Hydraulic Modeling Conducted by Santa Clara Valley Water District*

# San Francisco Bay Coastline

## Finding #3

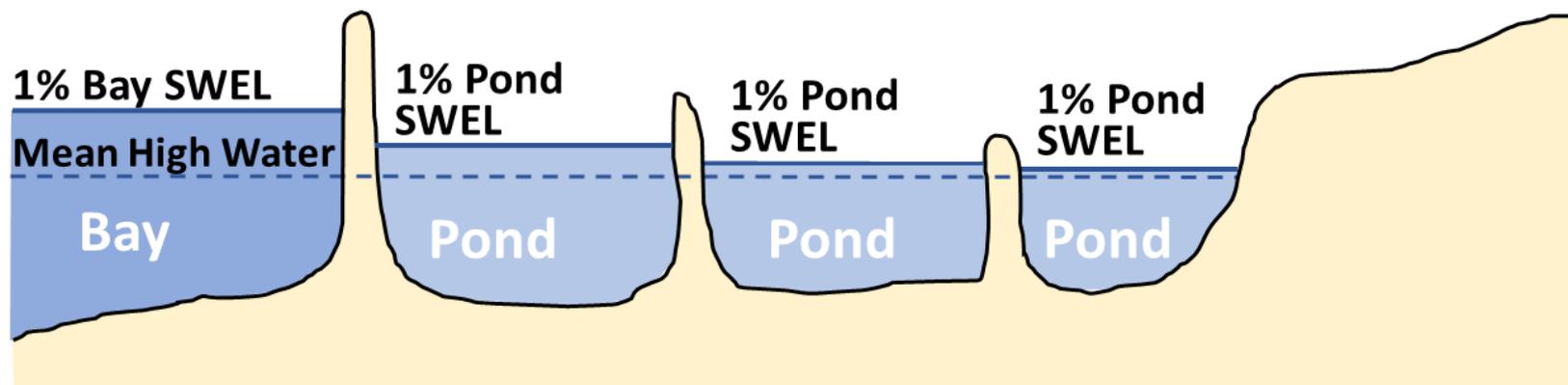
### **Breach sensitivity analysis is required for the Structural-Based Inundation Procedure described in FEMA's July 2013 report *Analysis and Mapping Procedures for Non-Accredited Levee Systems***

- Sensitivity analyses were submitted for 50-foot, 100-foot, and 200-foot breach widths with higher water levels observed in the ponds as breach width increased
- FEMA's July 2013 report recommends adding additional breaches until no change in water level is observed on either side of the breach (i.e., the addition of more breaches would not substantially change the water levels)
- Sensitivity analyses with wider breaches or additional breaches were not submitted; wider breaches (up to 675 feet) were noted in GEI report (2013) and could be considered reasonable for sensitivity analyses

# San Francisco Bay Coastline

## Finding #3

- Differences in the 1-percent-annual-chance stillwater elevations between the Bay and bayfront ponds indicated that this approach was crediting pond berms with flood protection that had not been proven based on submitted documentation
- The use of wider external breaches, additional breaches, or other factors require exploration through additional sensitivity analyses to confirm this difference is defensible



# San Francisco Bay Coastline

## Finding #3

### Legend

- Breach Location
- Pond Berm Embankment



# San Francisco Bay Coastline

## Finding #4

### **FEMA's study used a response-based analysis**

- **Compliant with FEMA's Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States (January 2005)**
- **Compliant with FEMA's Guidance for Flood Risk Analysis and Mapping: Coastal General Study Considerations (February 2018) and Coastal Water Levels (May 2016)**
- **Uses a 54-year hourly hindcast of water levels, waves, wind directions, and wind speeds to support a response-based analysis**
- **Pacific Coast and San Francisco Bay flooding issues are complex (high Bay water levels are not correlated with large wind and wind-driven wave events)**



# San Francisco Bay Coastline Finding #4

**The Appellant used a mixture of response- and event-based approaches**

- **Response-based approach used to determine Bay 1% SWEL**
- **Synthetic “design storm” hydrographs created based on two historic events**
  - January 1983 and December 1983
  - Peak water levels were scaled to match the response-based 1% SWEL
  - Duration of storms selected based on the two discrete observed events (no analysis of storm duration from other large Bay Area storms documented)
- **Scientific Resolution Panel for San Mateo County, CA (SRP CASMC120916) found this same approach did not characterize the 1-percent-annual-chance flood event**



# San Francisco Bay Coastline

## Finding #5

**The pairing of a 5-percent freshwater riverine discharge with the synthetic “design storm” hydrograph was not supported by the submitted documentation**

- **For an event-based approach, all storm characteristics of the selected “event” should be evaluated (including companion precipitation) to accurately represent the 1-percent-annual-chance flood event**
  - Guidance for Flood Risk Analysis and Mapping: Coastal General Study Considerations (FEMA, February 2018)
  - Coastal Water Levels (FEMA, May 2016)
- **Two storms were selected by the Appellant to develop a synthetic hydrograph**
  - January 22-28, 1983
  - December 2-5, 1983



# San Francisco Bay Coastline Finding #5

- **The January 22-28, 1983 storm was a strong atmospheric river coupled with a cyclone that elevated Bay tides for over a week (FEMA 2016)**
- **Heavy rainfall resulted in widespread flooding in the Santa Clara Valley (SCVWD 1983)**
  - Statistical return frequencies of peak flows for Santa Clara County creeks varied from less than 2-years to 25-years (some return frequencies may be approximate due to overbank flooding which may be excluded)
  - Rainfall varied from 16.6 inches on the west side, 9.4 inches to the south, and 5.8 inches on the east side

*FEMA (2016) Extreme Storms in San Francisco Bay – Past to Present. Prepared by AECOM, DHI, and BakerAECOM*

*SCVWD (1983) Report on Flooding and Related Damages in Santa Clara County; January 1 to April 1983. October 11, 1983*

# San Francisco Bay Coastline

## Finding #5

- **The December 2-5, 1983 storm was a strong low-pressure system with over 2 feet of surge concurrent with a rising tide on December 3, 1983 (FEMA 2016)**
  - Heavy rainfall did not exacerbate flood conditions in the December 1983 event
- **The February 2-9, 1998 storm was a strong atmospheric river with an offshore cyclone (more similar in climatology to January 1983)**
  - Three (3) feet of storm surge was recorded at the Presidio Tide Gage near San Francisco
  - Statistical return frequencies of peak flows for Santa Clara County creeks varied from less than 5-years to near 100-years (9 inches of rain fell between February 1 and 3, and another 7 inches fell on February 5) (SCVWD 1998)

*SCVWD (1998) Report on Flooding and Related Damages in Santa Clara County; February 2-9, 1998*



# San Francisco Bay Coastline Finding #5

**The pairing of a 5-percent freshwater riverine discharge with the synthetic “design storm” hydrograph was not supported by the submitted documentation**

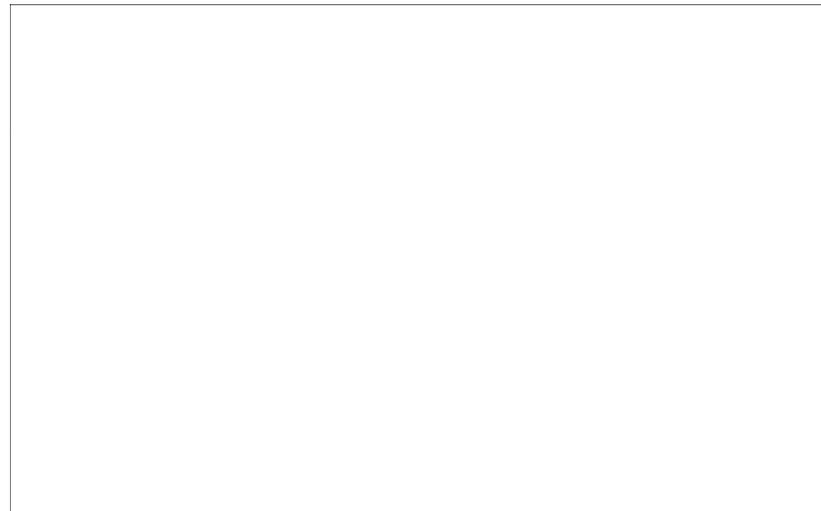
- **Additional Bay Area storms were not evaluated (not documented)**
- **Storm event selection based only on peak Bay water levels**
- **Additional justification needed to support pairing 5-year riverine discharge with the two selected events as representative of the 1-percent-annual-chance event**

# San Francisco Bay Coastline

## Finding #6

### Deficiencies in WHAFIS analysis noted throughout the study area

- **Example 1: Analysis Transect 32 includes a golf course that was carded as VE (i.e., dense, hard vegetation such as trees – see light green points in image to the right)**
- **Example 2: Dune (DU) cards were found on top of structures and buildings, such as shown by the pink marker on analysis Transect 16 in the image to the right**



# San Francisco Bay Coastline Finding #6

## Deficiencies in WHAFIS analysis noted throughout the study area

- **Robust independent QA/QC (as used in FEMA studies) would have reduced analysis errors**
- **SCVWD (2015) letter to FEMA noted QA/QC procedures that were being used; however, QA/QC documentation was not submitted**
  - “DHI Water & Environment has an internal review process for checking the model work”
  - “District staff are in the process of performing a complete review of the model results and should have the review completed by mid-June 2015”

*Letter dated May 14, 2015 from Dr. Liang Lee (Deputy Operating Officer, Santa Clara Valley Water District) to Juliette Hayes (Risk Analysis Branch Chief, FEMA Region IX) regarding FEMA California Coastal Analysis and Mapping Project/Bay Area Coastal Study: Coastal Hydraulic Modeling Conducted by Santa Clara Valley Water District*



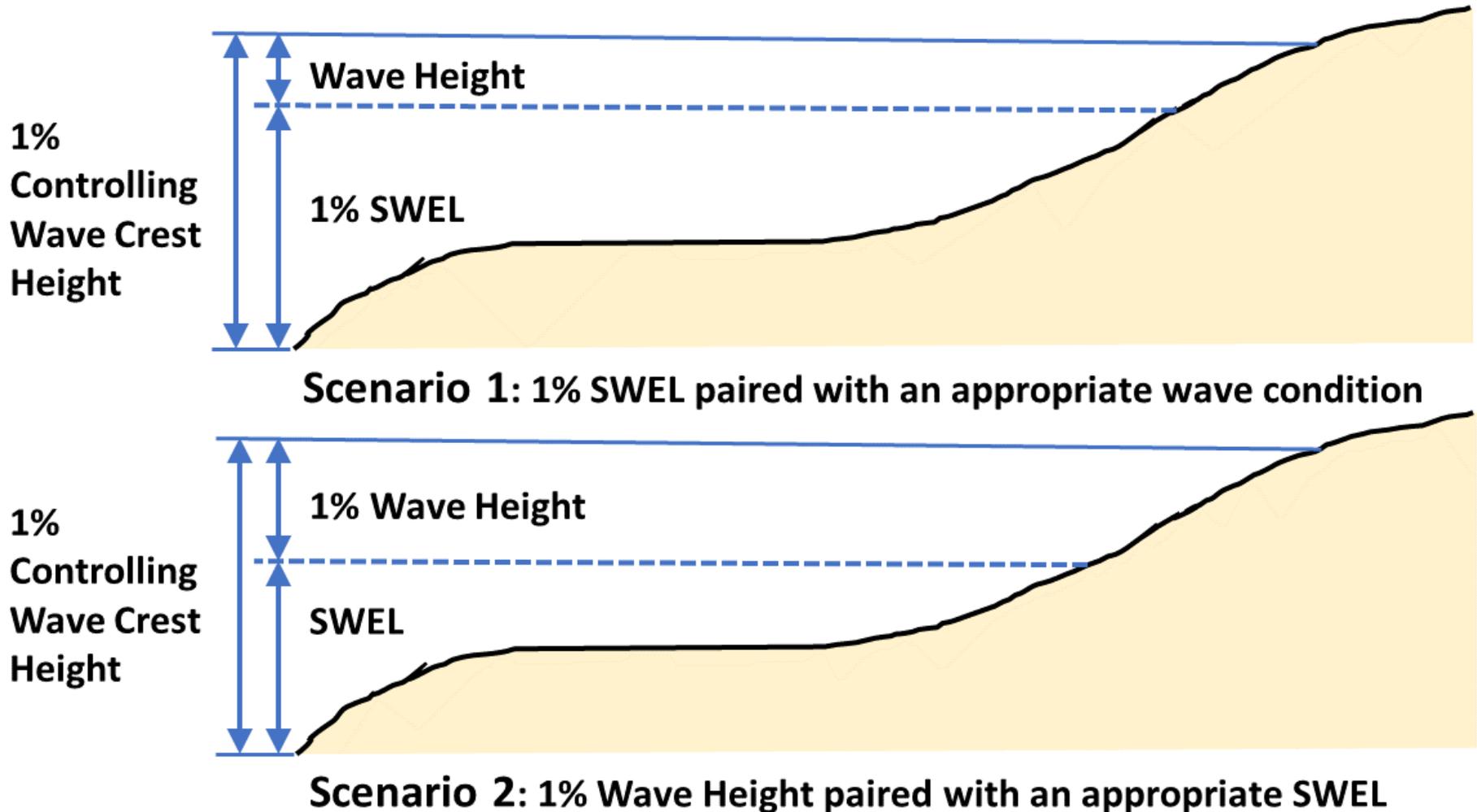
# San Francisco Bay Coastline Finding #7

**WHAFIS analysis and the translation to the mapping is challenging to understand based on the documentation provided**

- **FEMA and Appellant both used a two-scenario WHAFIS approach, with both scenarios representing the 1% wave crest elevation**

# San Francisco Bay Coastline

## Finding #7





# San Francisco Bay Coastline Finding #7

## **Benefits of using the two-scenario WHAFIS approach**

- **Constraining the combined elevation of the water level and wave height pair for each scenario with the 1-percent wave crest elevation ensured that neither scenario overestimated the 1-percent flood condition**
- **Results from the two scenarios were merged to form a single wave crest elevation profile that represented the most hazardous conditions along the length of the transect**



# San Francisco Bay Coastline Finding #7

## **FEMA study followed standard WHAFIS input procedures**

- **FEMA's WHAFIS boundary conditions were derived from the San Francisco Bay Hydrodynamic Model by using extreme value analysis of the 54-year time series model output at each transect**
  - 1% SWEL
  - 1% Wave Height
  - 1% Wave Crest Elevation
- **Resulting values were used to calculate the WHAFIS input values needed for the two scenarios using simple math**

# San Francisco Bay Coastline

## Finding #7

### **Appellant's WHAFIS analysis and mapping is challenging to understand based on the documentation provided**

- **Appellant's WHAFIS boundary conditions were derived from a series of eight (8) two-dimensional (2D) simulations, with four (4) simulations used to develop the boundary conditions for each scenario**
- **Peak water levels for the synthetic design storm hydrographs were scaled to match the target SWEL**
- **The four simulations for each scenario represent the two historic events**
  - January 1983 hydrograph (scaled) breached and non-breached
  - December 1983 hydrograph (scaled) breached and non-breached

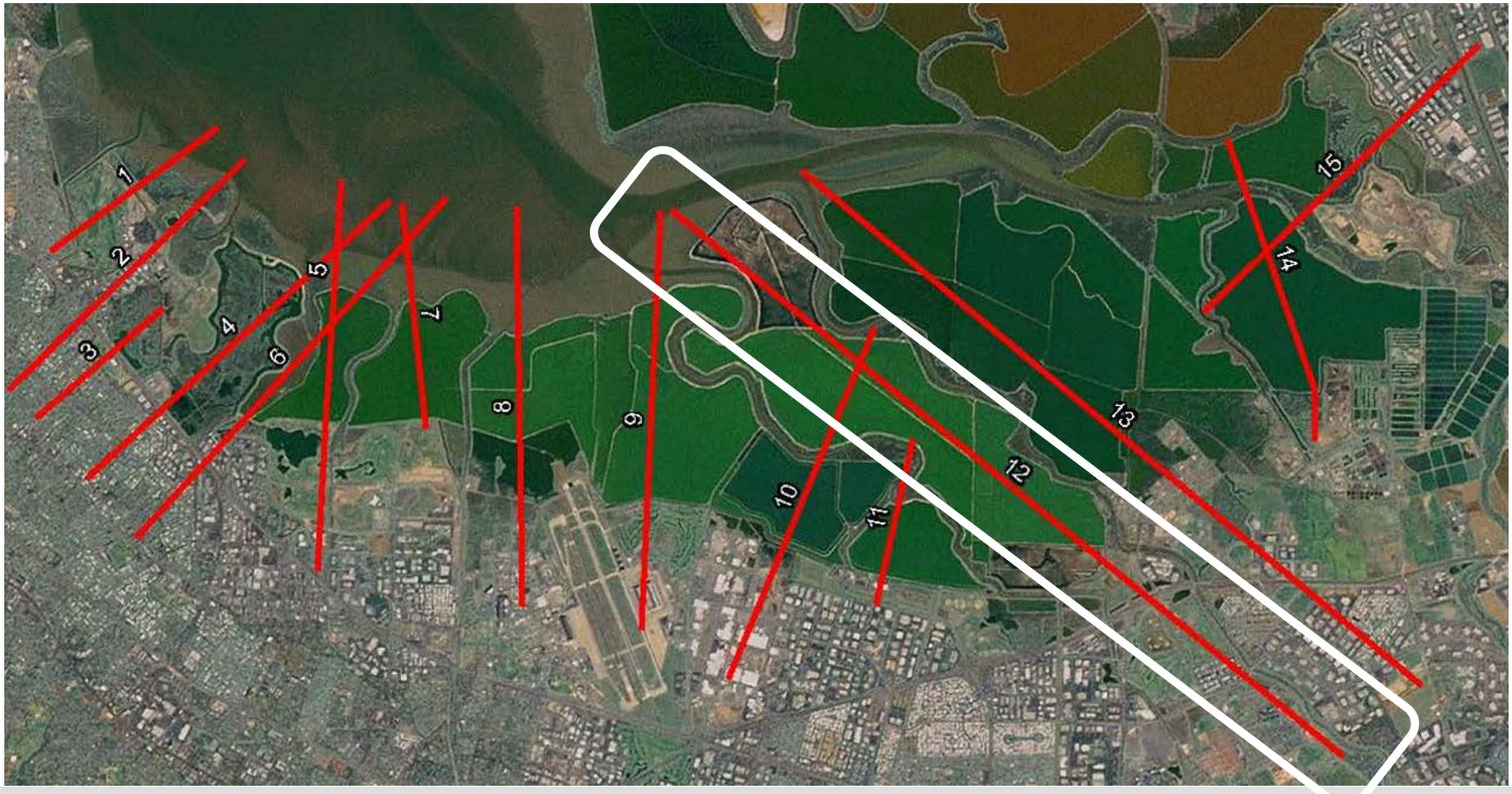
# San Francisco Bay Coastline

## Finding #7

- **The maximum water level across the four simulations was combined into a single result file for input to WHAFIS; however, the process for combining the four simulations was not documented**
  - Maximum water level at each grid cell?
  - Maximum water level in each pond?
- **Documentation submitted was insufficient to review interim results and steps used to develop WHAFIS input parameters**
- **Complexity of the approach makes reproducing the results challenging**
  - FEMA contractors often reproduce results within independent scripts and codes to verify the accuracy of presented results
  - Future updates to the analysis and mapping as the restoration continues and new coastal levees are constructed could be challenging

# San Francisco Bay Coastline Finding #7

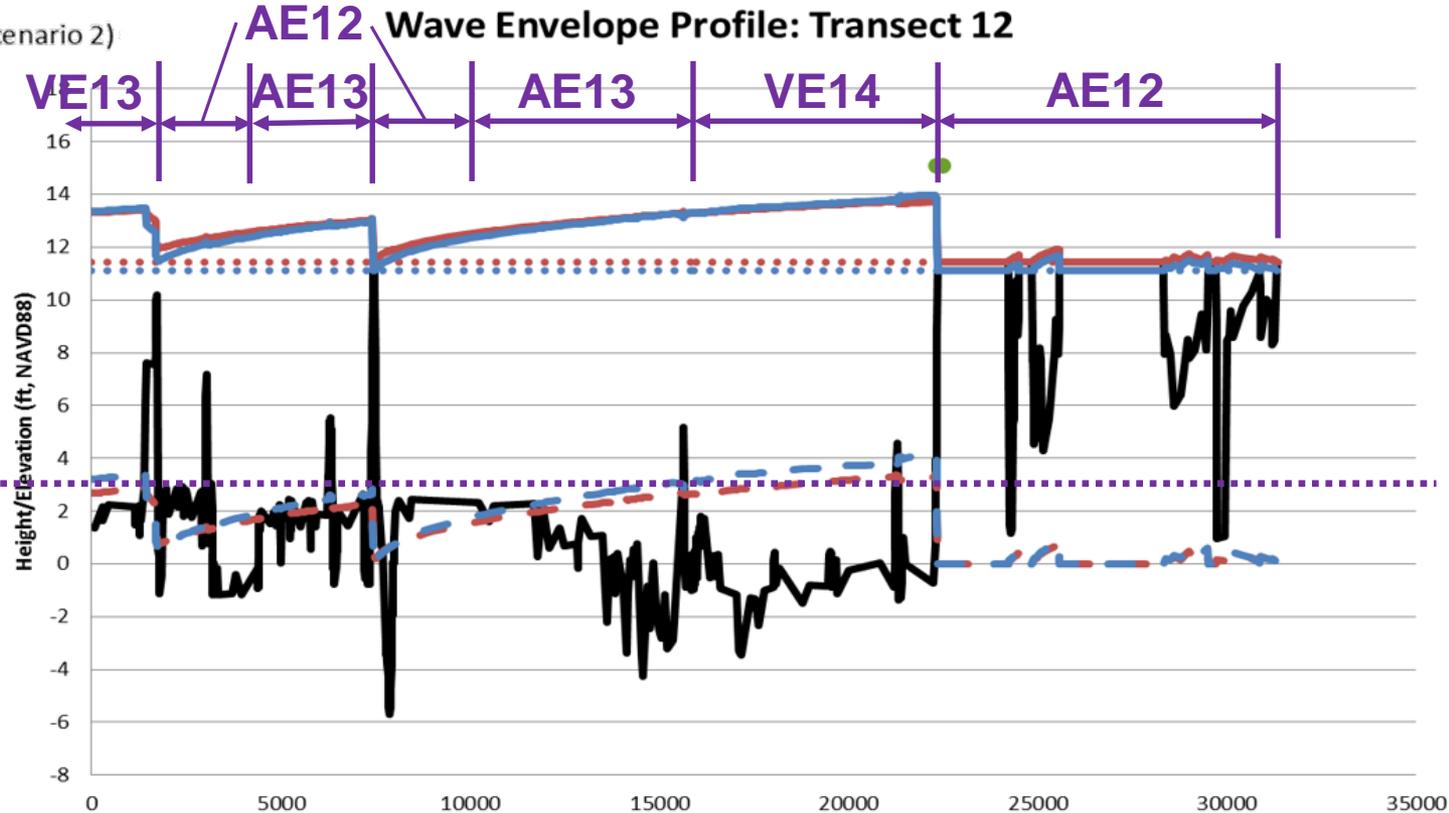
## FEMA Transect Layout



# San Francisco Bay Coastline Finding #7

## FEMA's Example WHAFIS Output

- Wave Crest Elevation (Scenario 1)
- Wave Crest Elevation (Scenario 2)
- Controlling Wave Height (Scenario 1)
- Controlling Wave Height (Scenario 2)
- Runup
- Water Level (Scenario 1)
- Water Level (Scenario 2)
- Terrain



3-foot wave height criterion for VE Zone designation

# San Francisco Bay Coastline Finding #7

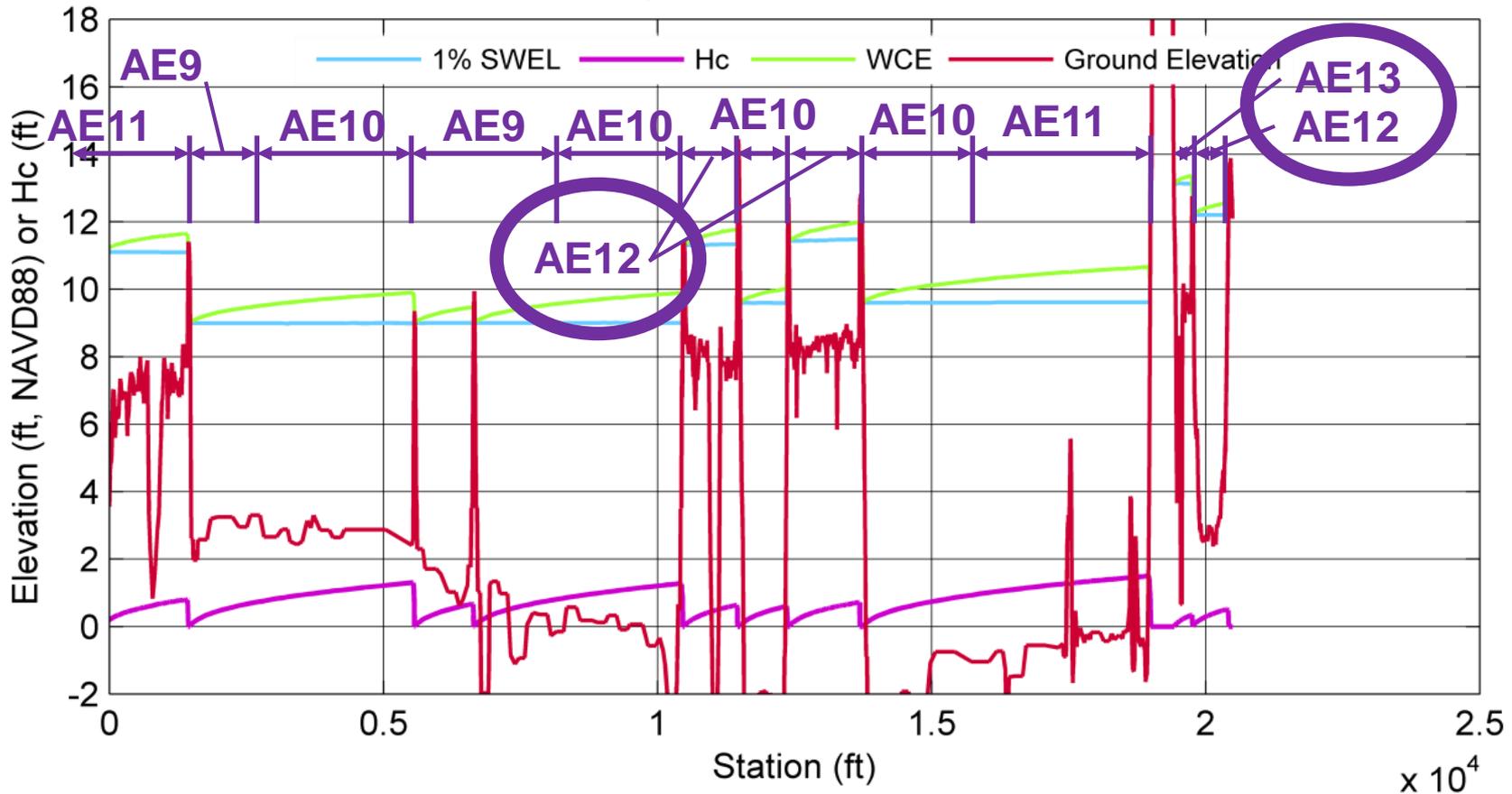
## Appellant's Transect Layout



# San Francisco Bay Coastline Finding #7

## Appellant's Example WHAFIS Output

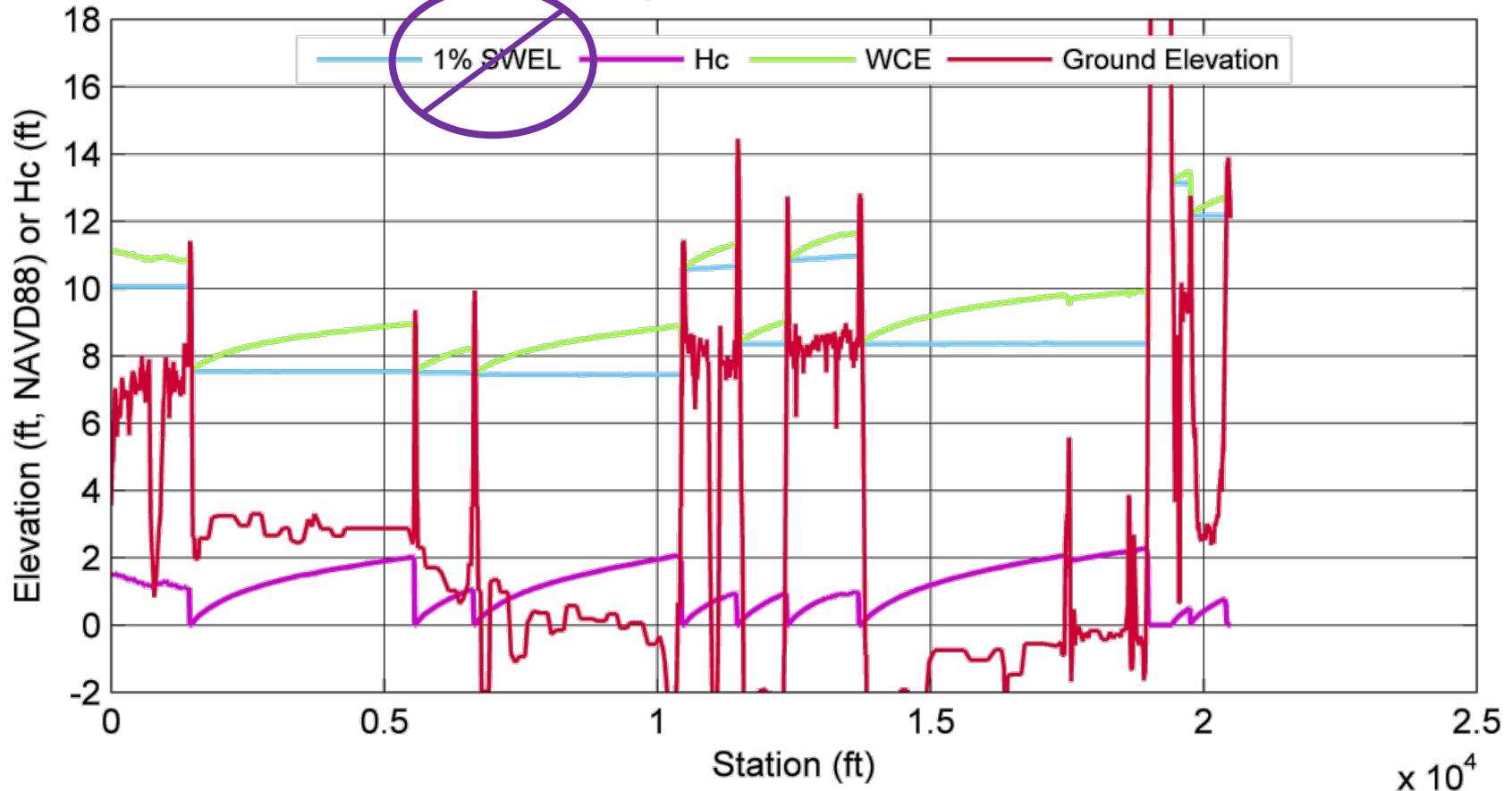
WHAFIS Output: Transect 45 - Scenario 1



# San Francisco Bay Coastline Finding #7

## Appellant's Example WHAFIS Output

WHAFIS Output: Transect 45 - Scenario 2



# San Francisco Bay Coastline

## Finding #7

**WHAFIS analysis and mapping is challenging to understand based on the documentation provided**

- **Appellant developed a Python program to extract relevant information from the WHAFIS output files to create WHAFIS transect profile plots and GIS shapefiles for 2D coastal hazards mapping**
- **Python program was not submitted with documentation for review**
- **High BFEs in some inland ponds are questionable**
- **Based on the complexity of the approach and the combinations of multiple 2D simulations and varying SWELs, it is not clear if the resultant mapping represents a 1-percent flood condition. Insufficient documentation was provided.**

# San Francisco Bay Coastline Findings Summary

## FEMA approach is scientifically correct

1. Appellant did not present any errors in FEMA's study. FEMA's approach is consistent with FEMA coastal analysis and mapping guidelines.

## There are deficiencies in the Appellant's approach

2. Not compliant with FEMA's July 2013 report *Analysis and Mapping Procedures for Non-Accredited Levee Systems*
3. Breaching methodology is not sufficiently supported
4. Mixture of response- and event-based approaches does not adequately approximate a 1-percent-annual-chance flood event
5. Companion precipitation may be underestimated with the 5-year freshwater riverine discharges, insufficient documentation
6. WHAFIS analysis carding errors were noted
7. WHAFIS analysis and mapping approach is complex and, based on submitted documentation, does not represent a 1-percent-annual-chance flood event

# Questions?

**A.3. APPENDIX C-SANTA CLARA COUNTY PRESENTATION TO  
SRP**

# Santa Clara County - Summary of Appeal Information

## Presentation to SRP

Julio A Zyserman, DHI Water & Environment  
Emily Zedler, SCVWD



# Contents of Presentation

- San Tomas East Levee & Hwy 237 Embankment
- Summary of BakerAECOM Methodology
- Issues with BakerAECOM Methodology
- Need for Alternative Approach based on Coastal Setting
- Main Results from Alternative Approach
- Sensitivity of Results to Breach Width
- Effectiveness of Berms to Attenuate Flooding

Julio A Zyserman, DHI Water & Environment  
Emily Zedler, SCVWD









Source: Google Earth

Scale 100 ft.

**BORING/CPT LOCATION MAP**



**SAN TOMAS AQUINO LEVEE EVALUATION PROJECT  
SANTA CLARA COUNTY, CALIFORNIA**

**JOB NO.: 2014-101-TO5**

**PLATE NO.: 3**

# Hwy 237 Embankment



Hwy 237 Embankment- Land Mass?



8 to 13 ft Above 1% Coastal Flood Elevation

Ties into FEMA-accredited levee

Ties into FEMA-accredited levee

0.045 Miles



GIS themes are for illustration and general analysis purposes only and are not accurate to surveying or engineering standards. Information is not guaranteed to be accurate, current, or complete and use of this information is your responsibility.

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# Summary of BakerAECOM Methodology

Coastal boundary conditions developed from 54-year hindcast of storm surge and waves. **All baywide embankments and levees remain intact in regional models.**

**Response-based approach** applied to analyze TWL at outboard shoreline. DIM/TAW used to calculate wave effects.

Overland waves calculated using WHAFIS for two joint probability conditions (**event-based approach**). All embankments removed and bay water levels propagated horizontally.

Embankments assumed to protect against waves in WHAFIS.

# Issues with BakerAECOM Methodology

Assumes that the entire system of embankments fails simultaneously throughout study area in local analyses.

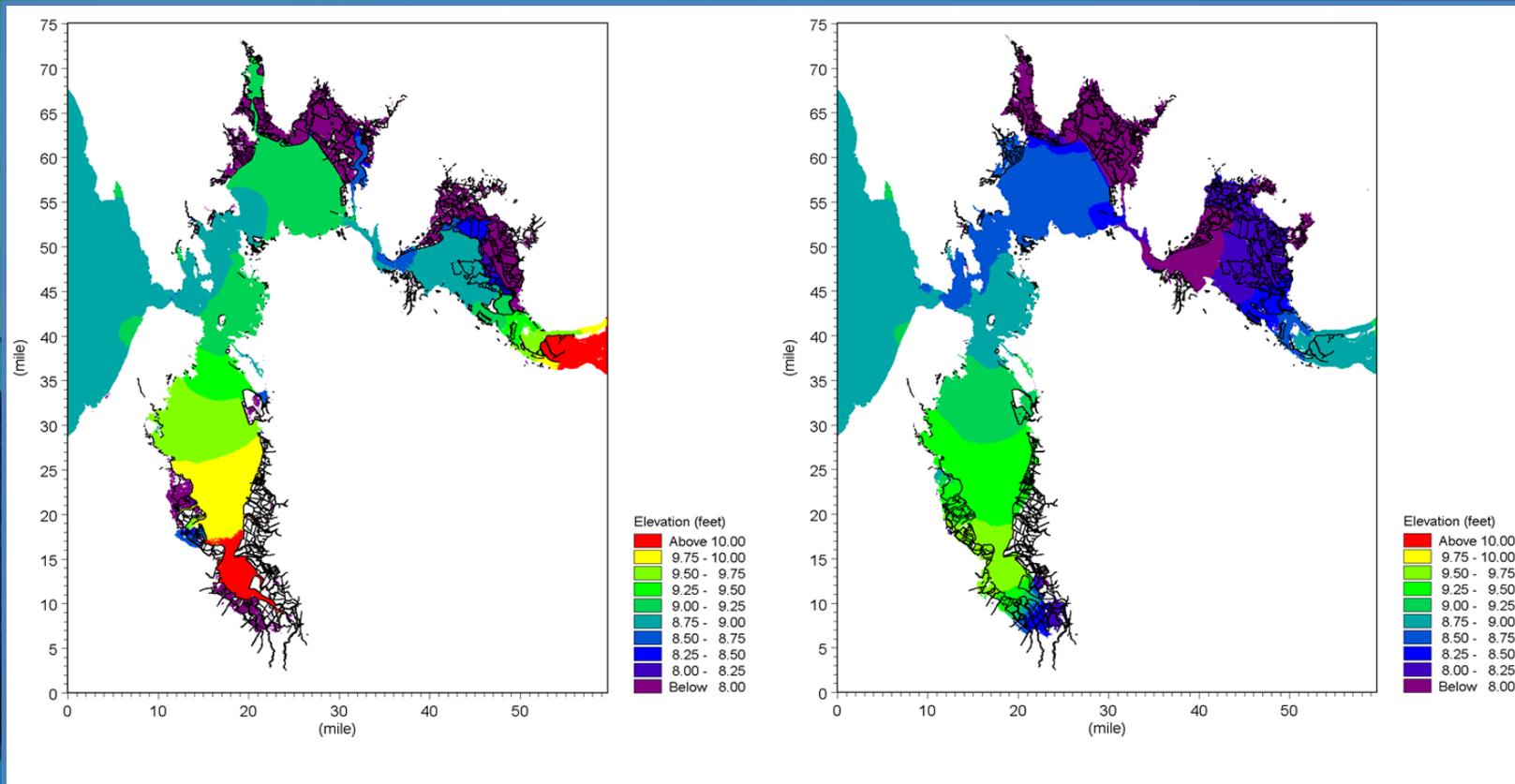
Maximum flood level persists as a constant water level for an indefinite period of time.

Ignores effects from bottom roughness and/or tidal damping through failed structures.

Leads to conservative over-estimation of flood water levels at inland locations.

➔ **Need for alternative approach**

# If All Embankments Failed Simultaneously In Regional Model

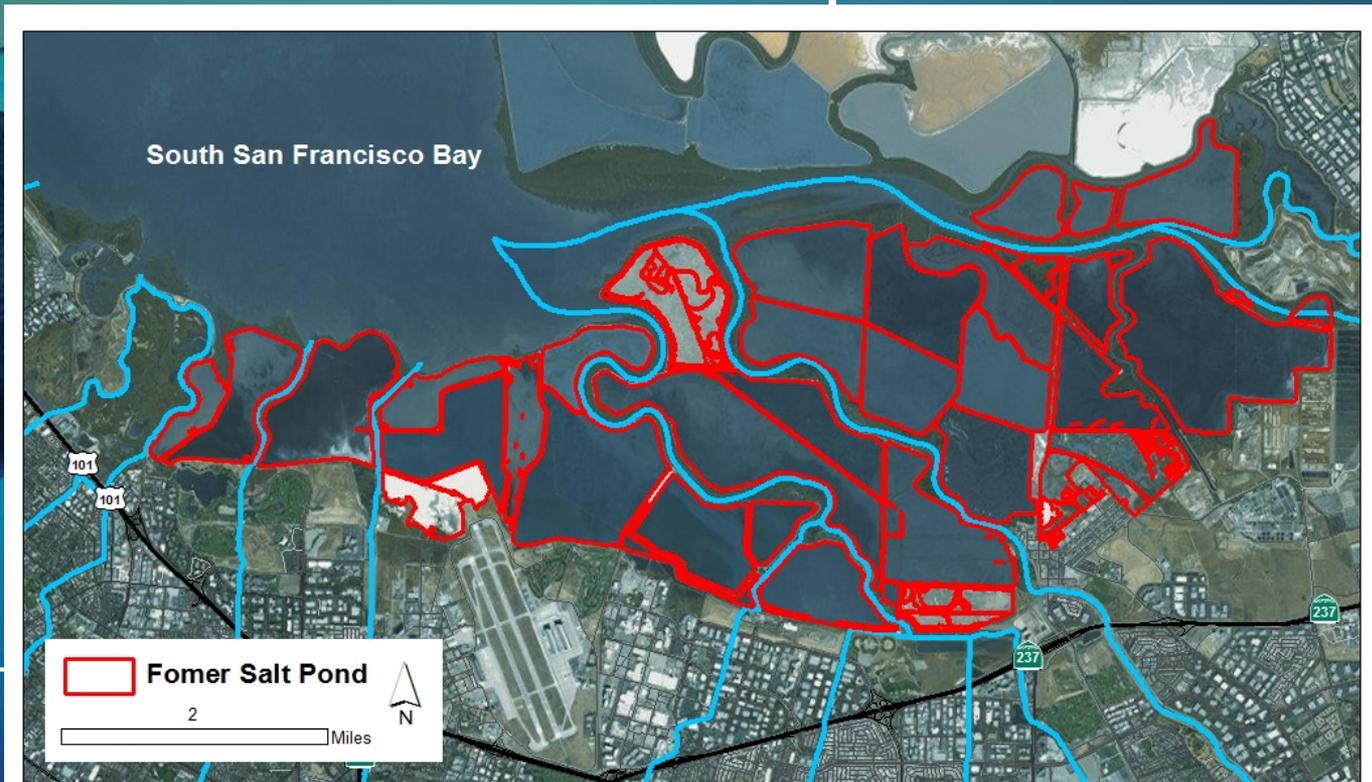


Julio A Zyserman, DHI Water & Environment  
Emily Zedler, SCVWD

# Coastal Setting - Santa Clara County

## Salt Ponds

- increase in size and number from West to East
- embankments break waves
- ponds provide storage during storms
- ponds prevent routine flooding from high tides where shoreline levees are low or absent
- even lower water levels in ponds if levees not breached



## The Berms Surrounding the Salt Ponds:

- Were constructed of Bay mud, in the 1850's
  - Have been nominally maintained since salt production stopped in 2003
  - Were acquired by the Fish and Wildlife Service in 2003; some have been restored to tidal flushing since then
  - Have provided flood protection - storage and wave breaking - despite levee fragility
- Deserve some credit in flood analyses



# Summary of Methodology

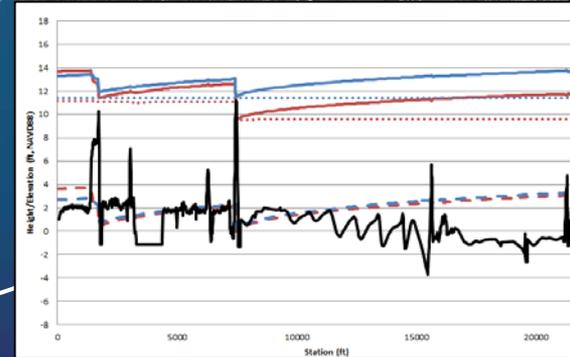
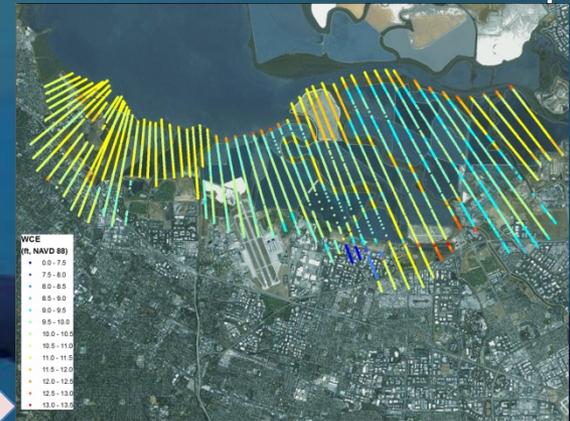
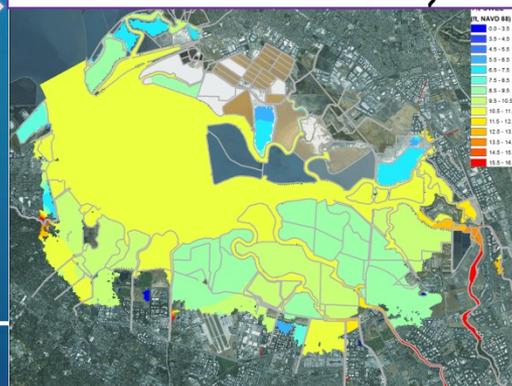
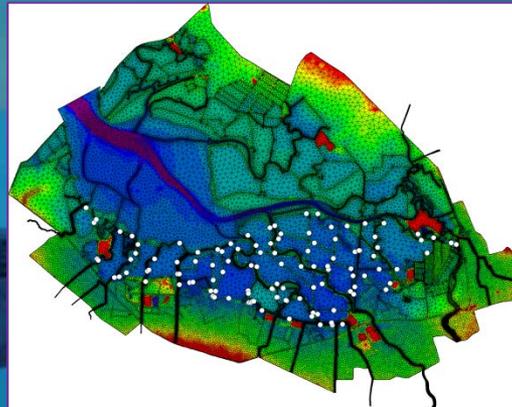
Regional 2D Model  
(with intact levees)



Local 2D Model  
(with breaching)



56 WHAFIS Transects



# Summary of Methodology

## Regional 2D Model

- Hindcast Period 54-years (1956-2009)
- Tide
- Storm Surge
- Wind waves (Seas)
- Swell waves

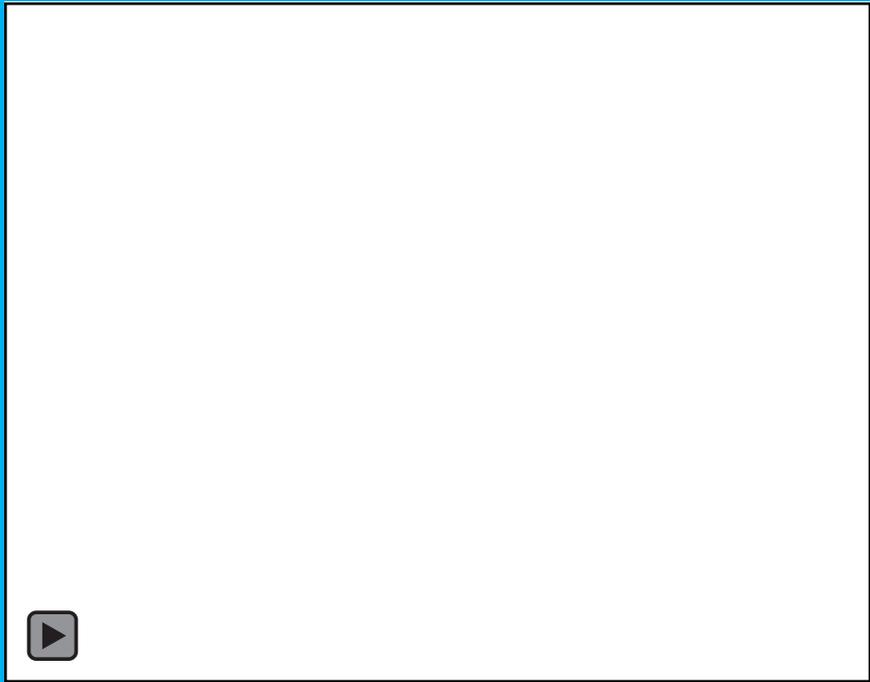
### Deliverables

- 15-minute water levels
- 1-hour waves
- 1% and 0.2% statistics

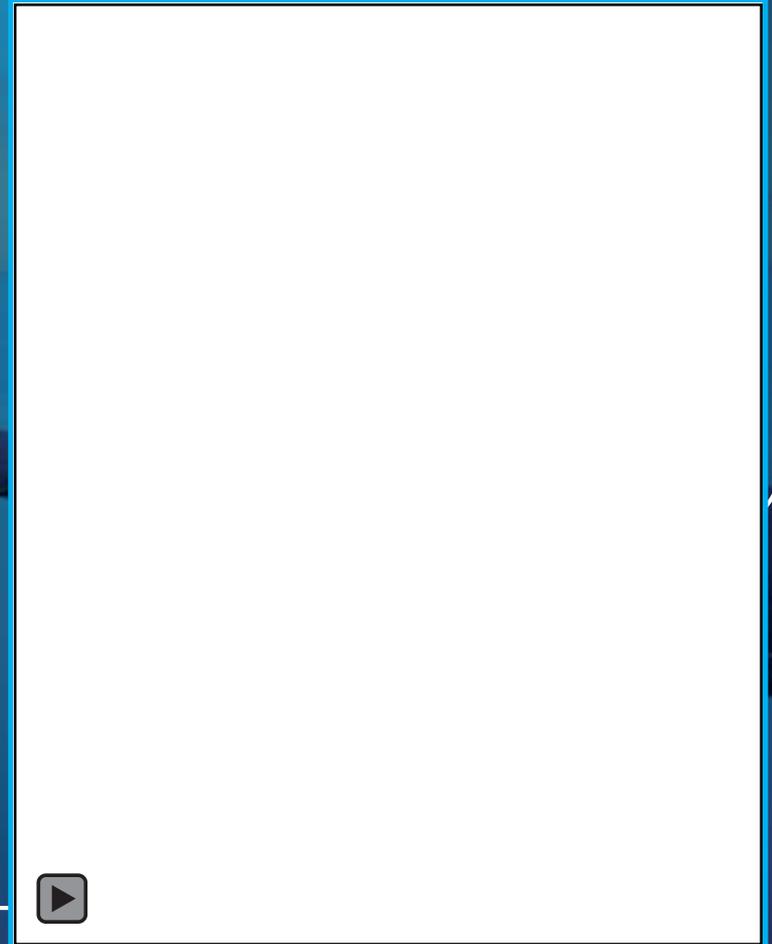


# Summary of Methodology

Water Surface Elevation



Current Velocity



Julio A Zyserman, DHI Water & Environment  
Emily Zedler, SCVWD

# Summary of Methodology

## Local 2D Storm Surge Model (MIKE 21 HD FM)

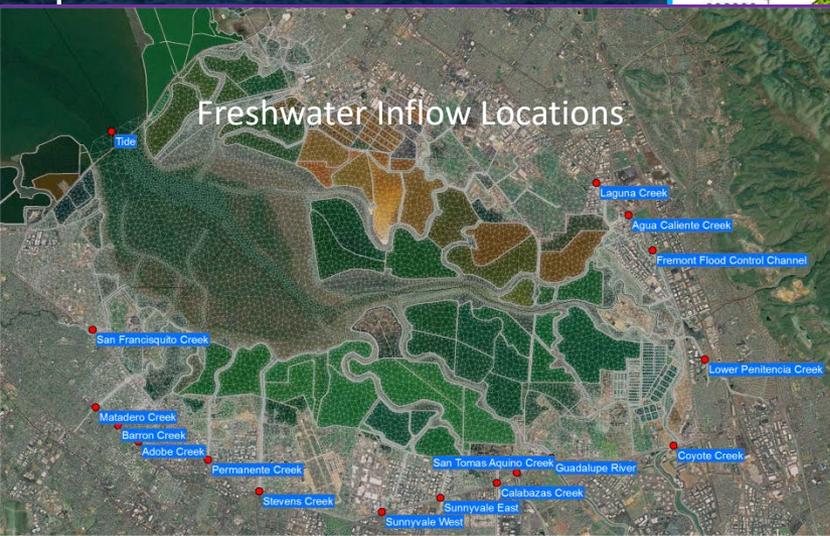
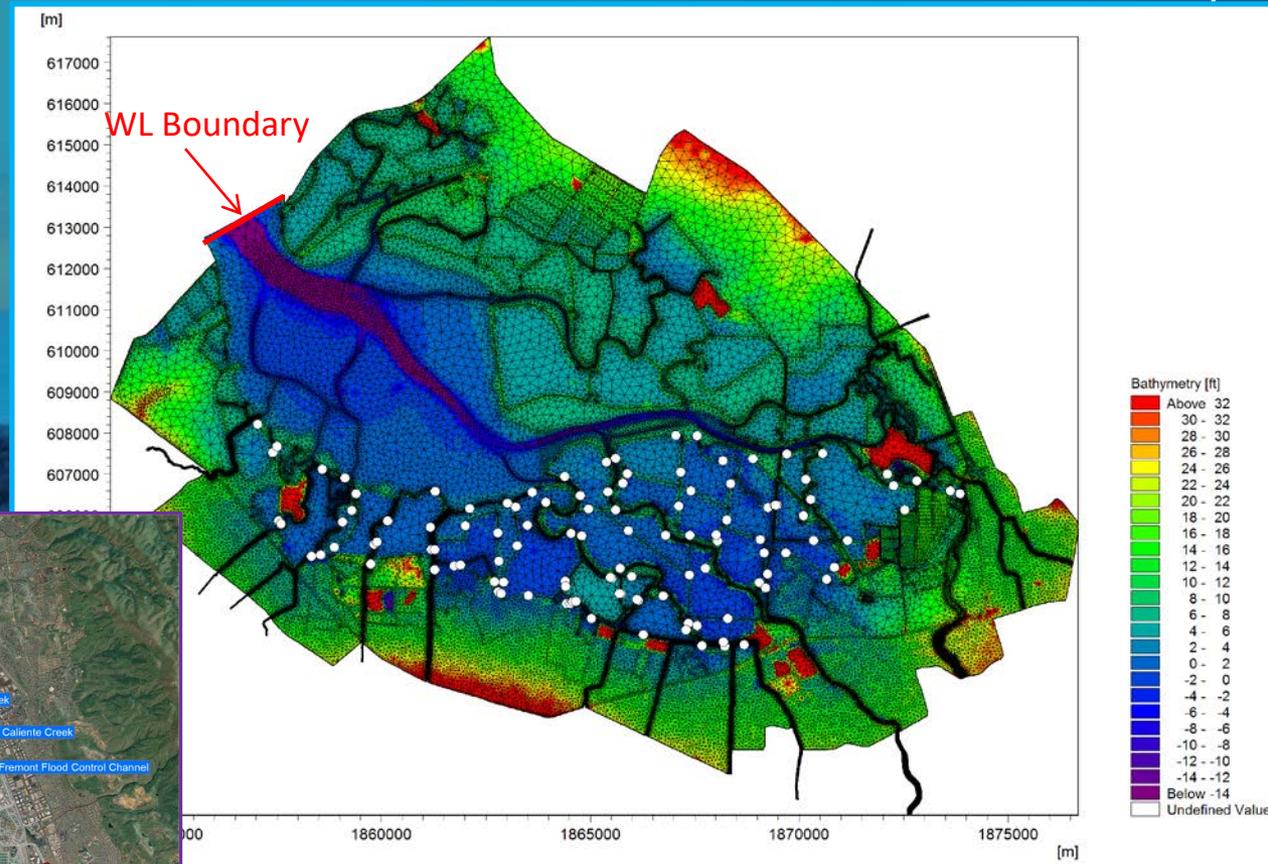
WL boundary from Regional Model  
(1% and 0.2% events)

Freshwater inflows (16)  
(5-yr hydrographs)

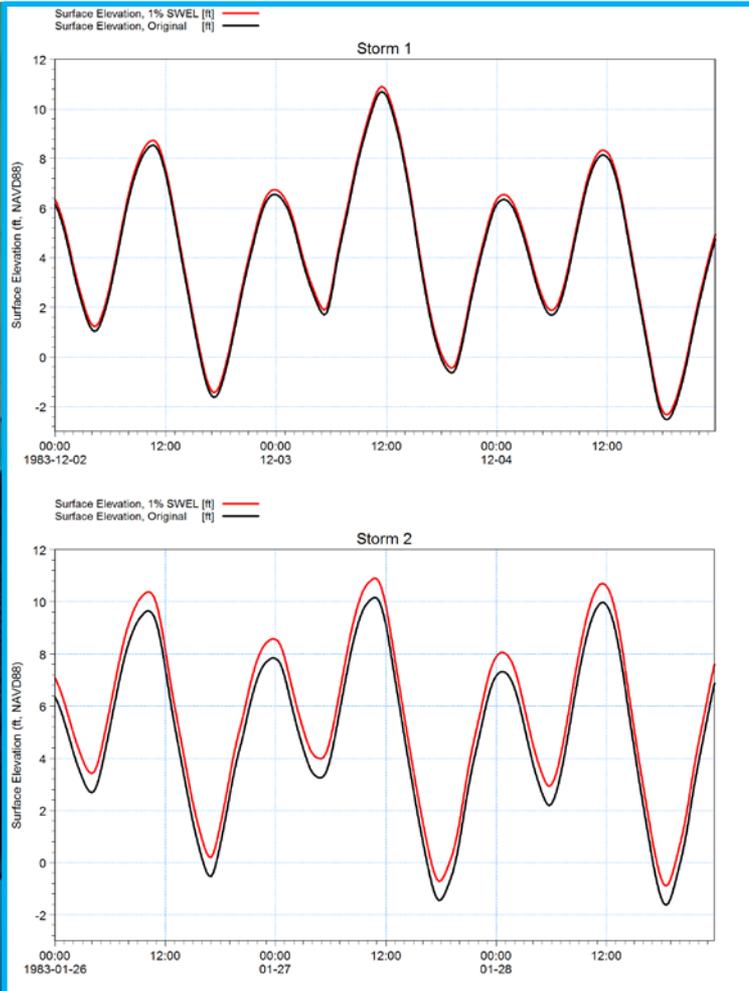
Winds from local observations

Calibrated / validated to local water level  
gages for high water events

100-foot breaches (117 total)



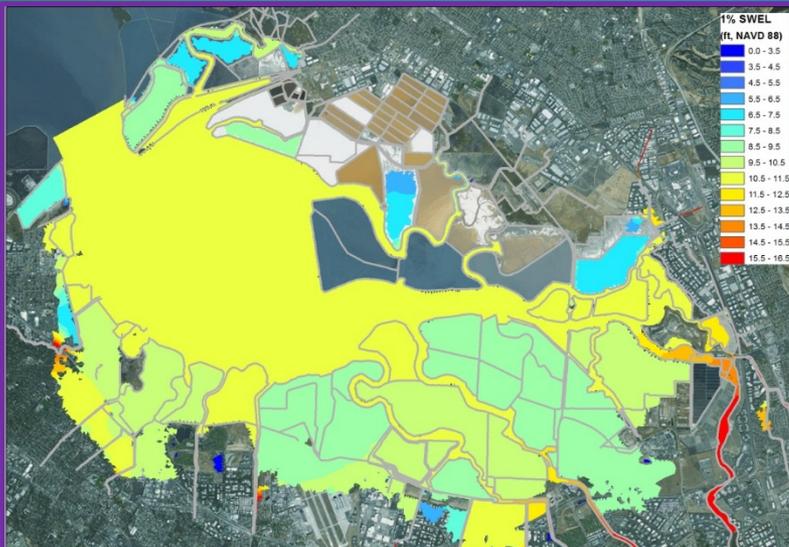
# Summary of Methodology



- 2 probabilities (1% and 0.2%)
- 2 dynamic events (storms)
- 2 scenarios: breached and intact embankments (to pick high WLs in creeks)
- For each probability, calculate combined 2D SWEL from 2 storms and 2 breaching scenarios

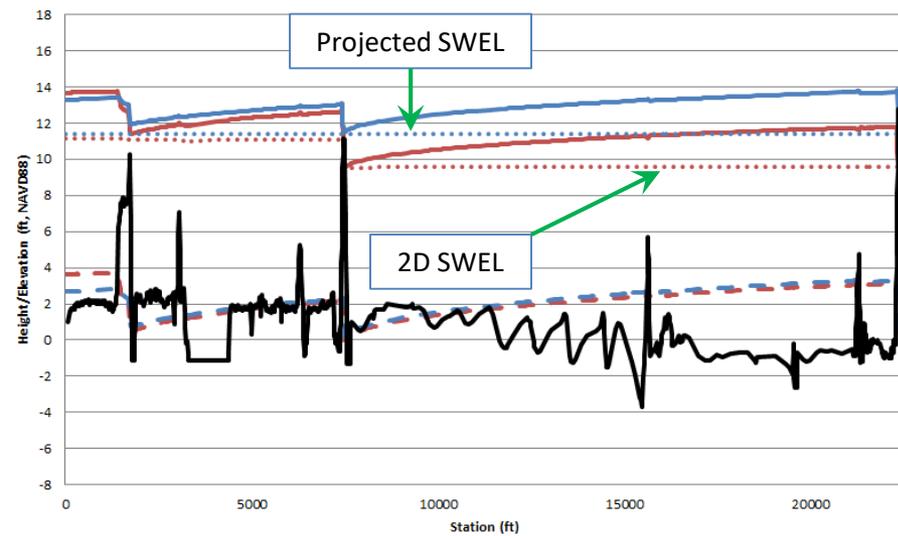
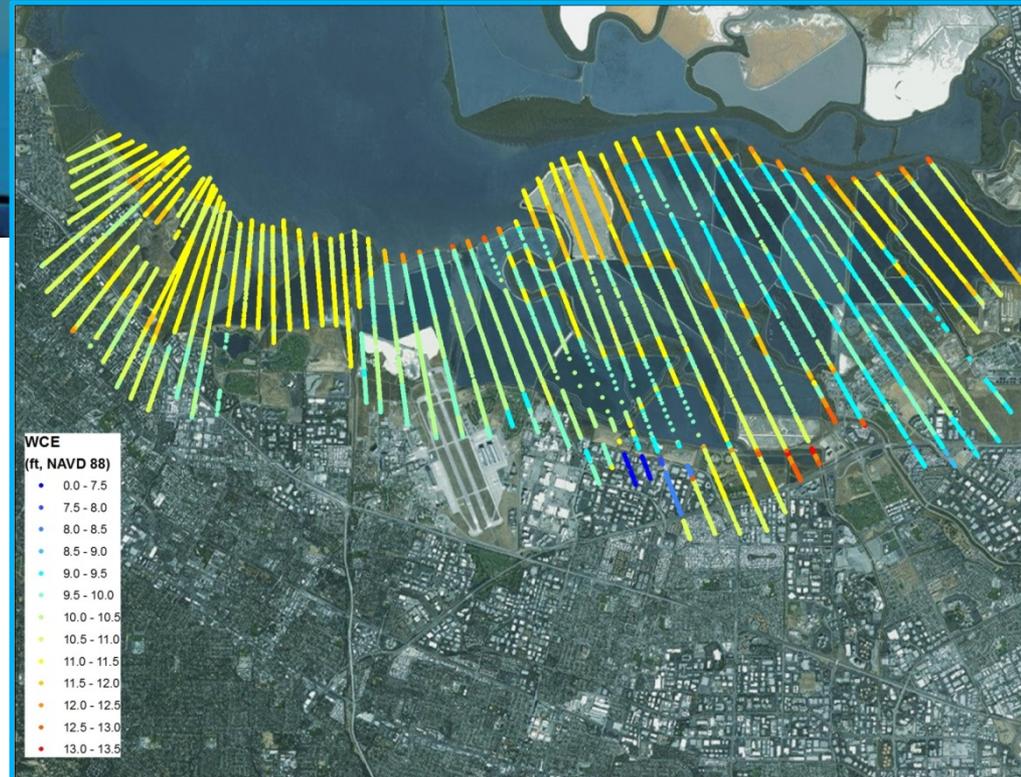
# Summary of Methodology

## 2D Model Still Water Elevation (SWEL)



Maximum of two Scenarios used for mapping:  
1% WCE = 1% SWEL + Associated Wave  
1% WCE = 1% Wave + Appropriate SWEL

WHAFIS Transects Utilizing 2D Model SWEL



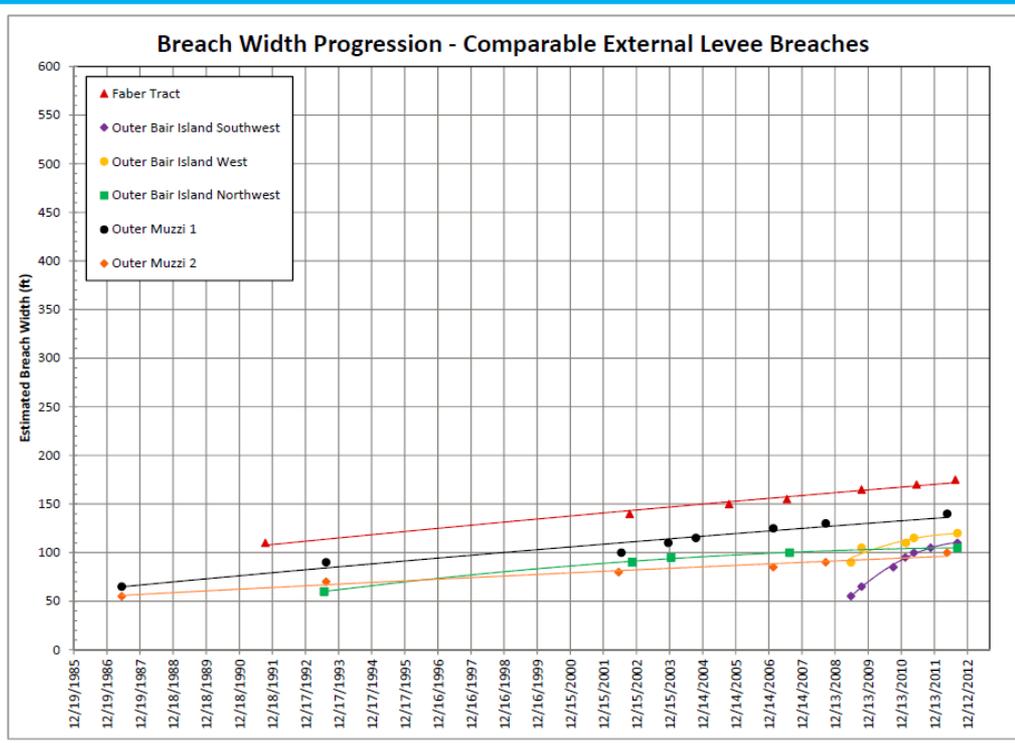
# Summary of Methodology

## Attempt to Meet Regulatory Requirements When Defining Breaches:

- 117 Breaches Placed in Geometry
- Breach locations adopted in coincidence with:
  - Relic channels (weaknesses in levee system)
  - Probable restoration schemes from preliminary management plans
  - Where overtopping has occurred
- Breach Width – 100 ft - Based on Maximum Historic Breaches in South Bay (GEI 2013)

# Statistics of existing breach widths at comparable breach locations (from GEI, 2013)

Breach Type Category	Average Current Breach Width (feet)	Minimum Current Breach Width (feet)	Maximum Current Breach Width (feet)
External	125	100	175
Tidal-Fluvial	86	50	150
Internal	66	25	160



Average of existing breach widths = 92 ft.

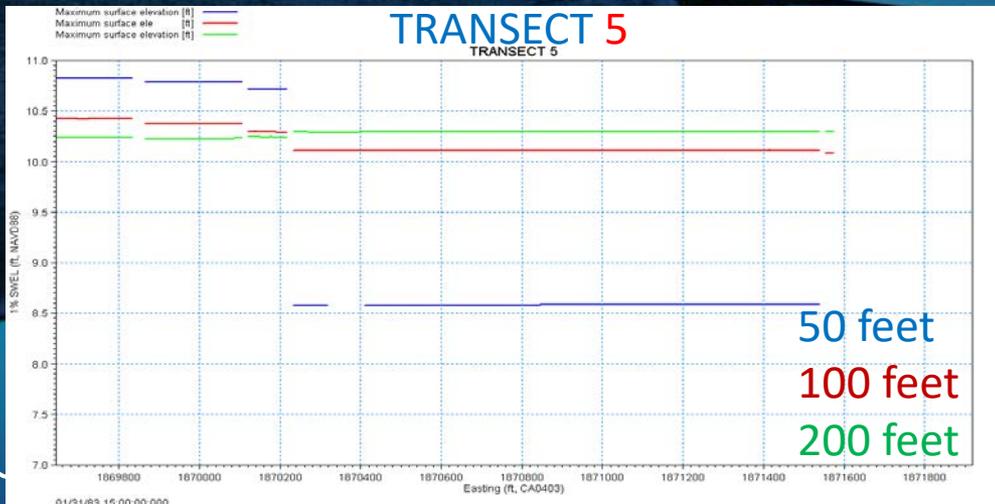
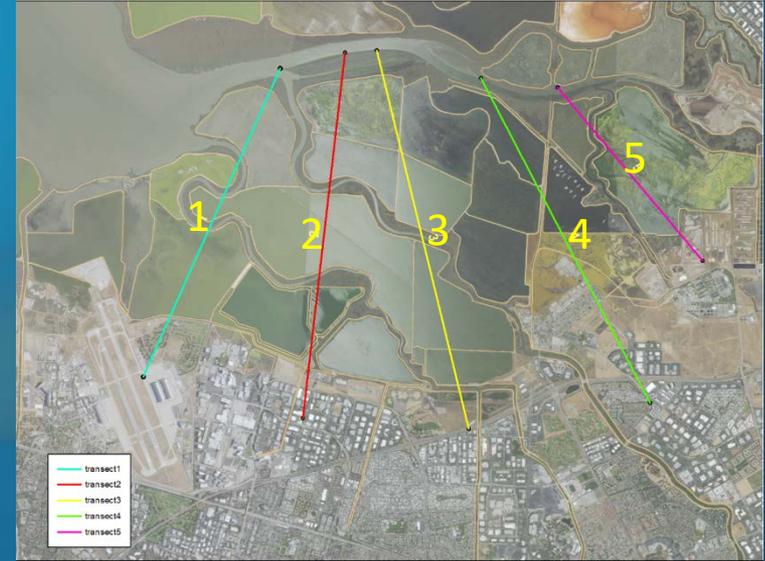
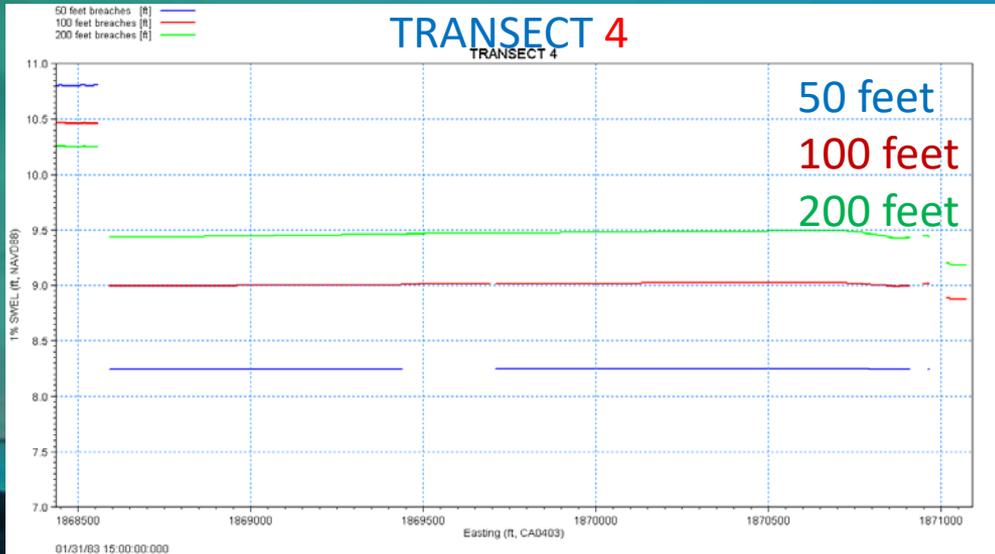
100 ft. adopted for consistency with LAMP

Rate of breach development <<<< 14 ft./yr. for internal and tidal/fluvial



- Breach placement ensures there is a pathway to all potential flooding areas
- Consistent with Structural Based Inundation Procedure from FEMA's LAMP Document
- No upstream or downstream in coastal environments
- Maintenance plan: once breach opens and reaches 100 ft. width, maintain it at that state. If not, flood map can be updated

# Sensitivity to Breach Width Investigated Nevertheless



# Why Use This Methodology?

## Pond Storage is Accounted for

- Base Flood Elevations based on physics, especially in the ponds

## Mass Conserved using Dynamic Simulation

- Can lead to smaller floodplain area, especially beyond shoreline levees; flow is forced through narrow openings

## Water Surface Elevations include Coincident Creek Flows in 2D Modeling

- Results in higher flood levels in channels due to combined coastal and riverine flood events

# Comparison of Methodology to FEMA Approach

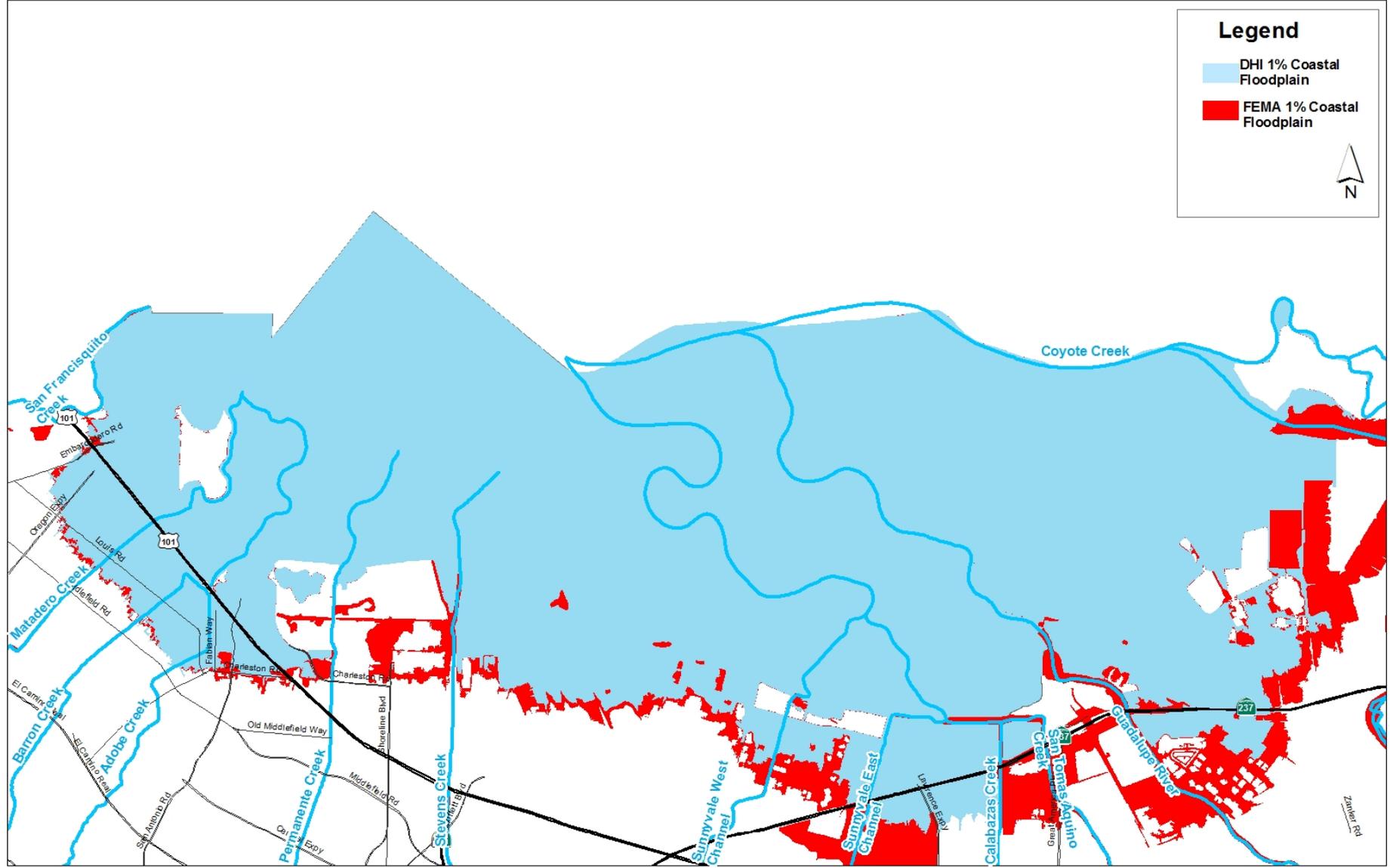
**Main difference is the treatment of SWEL**

<b>METHODOLOGY</b>	<b>FEMA</b>	<b>DHI</b>
<i>Regional Model Water Levels as basis for Boundary Conditions of SWEL analysis</i>	X	X
<i>Regional Model Waves as basis for Wave Boundary Conditions of analysis</i>	X	X
<i>Complete removal of all levees for SWEL analysis</i>	X	
<i>Levees intact for SWEL (interaction with freshwater inflows)</i>		X
<i>Partial levee failure (breaching) for SWEL analysis</i>		X
<i>Detailed 2D modeling to route tide / storm surge flood through ponds</i>		X
<i>Performed Response Based wave runoff at outboard Levees</i>	X	X
<i>Performed overland Wave analysis with WHAFIS</i>	X	X
<i>Levees intact for WHAFIS wave analysis</i>	X	X
<i>2 Scenario event based joint probability for WHAFIS analysis</i>	X	X
<i>Event based approach for inland wave runoff</i>	X	X
<i>Map worst case between Levees removed (or breached), and levees intact</i>		X
<i>Consideration of Freshwater Inflows</i>		X

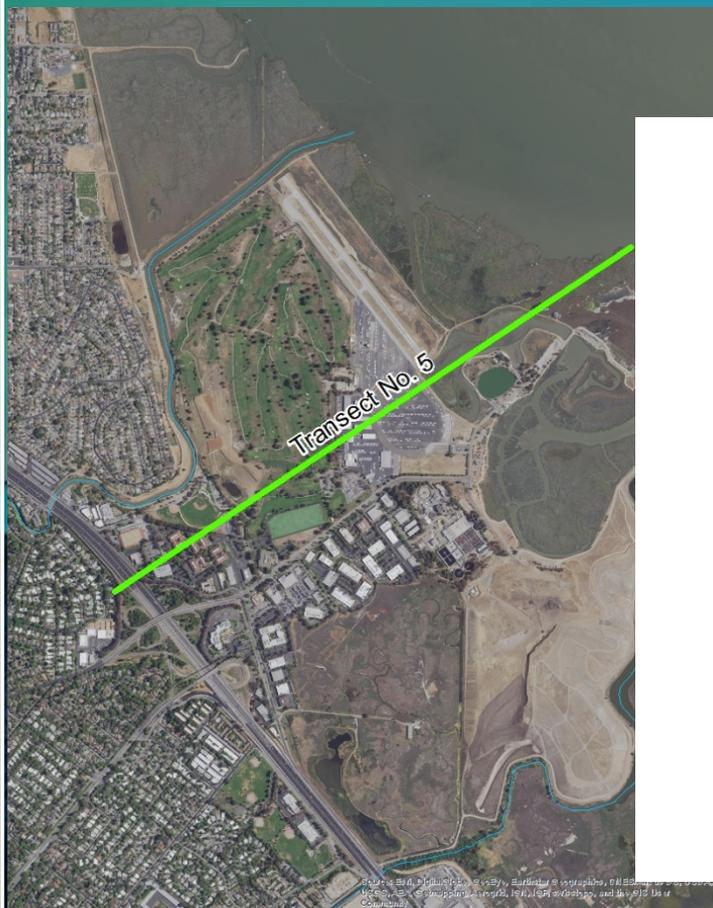
**In the area where we differ with FEMA, records of historical events over many years do not show occurrence of coastal flooding)**



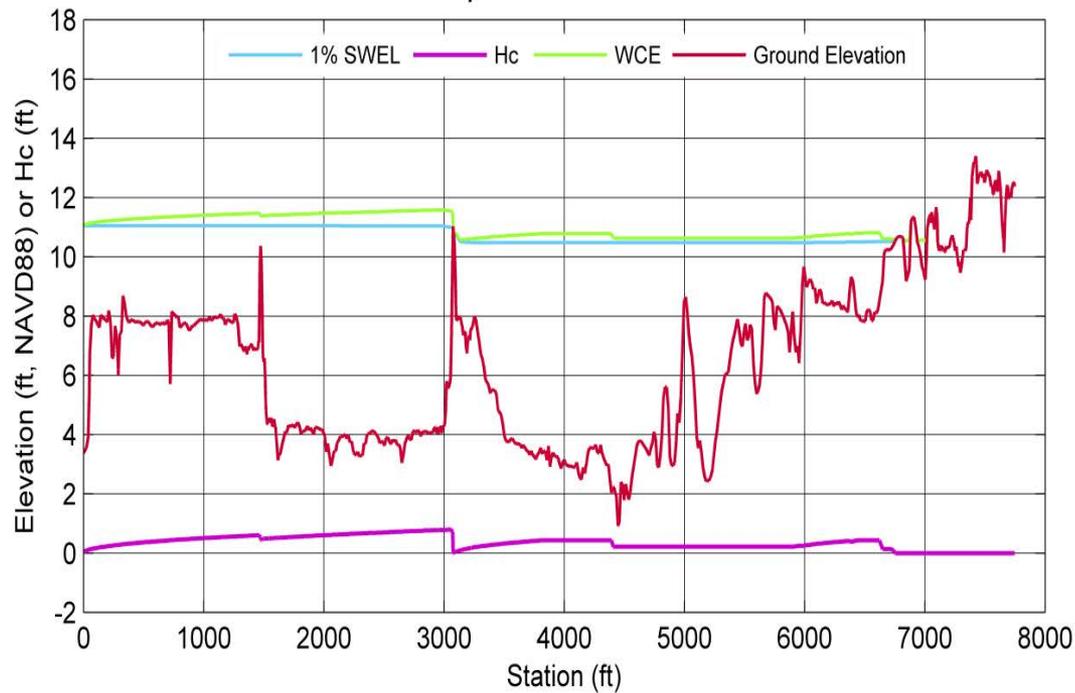
# Main Results – 1% Coastal Floodplain:



# WHAFIS Transect Results – PALO ALTO



WHAFIS Output: Transect 5 - Scenario 1

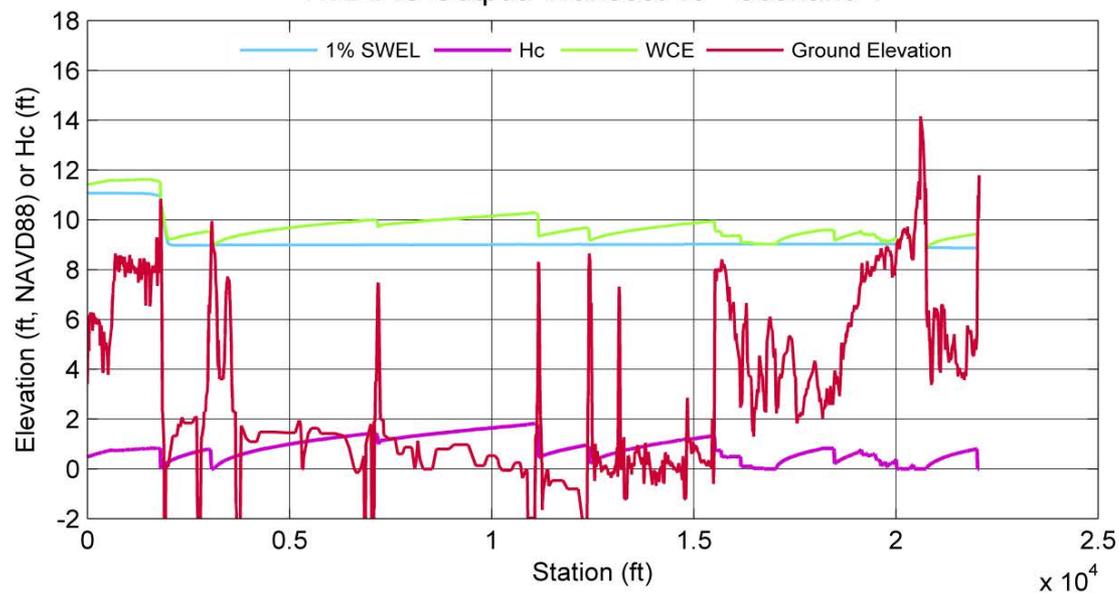




# WHAFIS Transect Results – SAN JOSE



WHAFIS Output: Transect 48 - Scenario 1



**Thank you very much for your attention**  
**Questions?**

Julio A Zyserman, DHI Water & Environment  
Emily Zedler, SCVWD



**A.4. APPENDIX D-LIST OF SANTA CLARA COUNTY  
DOCUMENTS OUTSIDE OF APPEAL PERIOD**

Appendix D List of documents that Santa Clara has suggested the SRP be provided in their appeal( attachment A) and which FEMA has indicated the panel should not consider since they were provided outside the appeal period.

**Attachment A Santa Clara request for SRP.**

*A list of proposed references to be included as part of the information for the SRP is provided here.*

*/1/ Alameda County Basis of Appeal Memo to FEMA, August 2018*

*/2/ DHI, 2017. Technical Memorandum: Event Based versus Response Based Coastal Analysis in southern Alameda County. Submitted to ACFCWCD, 20 April 2017*

*/3/ DHI, 2017. South San Francisco Bay Alameda County Coastal Hazards Analysis. Report by DHI Water &Environment for FEMA Region IX and Alameda County Public Works Agency. July 2017.*

*/4/ Event Based Acceptance Memo from BakerAECOM dated 2017.06.29*

*/5/ Most recent Comment & Response Forms between from DHI/ACFCD to FEMA BakerAECOM, 2017.07.28 and DHI Appendix to Comment Response form dated 2016.02.08*

*/6/ Review Memo from BakerAECOM dated 2015.09.29*

*/7/ Various presentations. To national IPT (2013.03.21 and 2013.03.27), FMA conference (2017.09.06) and FEMA workshop at Santa Clara Valley Water District (2013.04.23)*

## **A.5. APPENDIX E-CHRONOLOGY OF EVENTS**

## Appendix E Chronology of Events Santa Clara

The table below provided by FEMA includes the major study milestones and connections to interactions with Santa Clara Valley Water District (SCVWD) and Valley Water (VW) officials throughout the study and following the end of the 90-day appeal period. Please note that at SCVWD was rebranded as VW at some point in the timeframe covered, so the same organization is referenced both ways in the table.

<b>Milestone</b>	<b>Date</b>
Project Kickoff meeting at SCVWD office	April 22, 2013
Coastal analysis completed	April 2014
Floodplain mapping completed	September 2014
Draft data shared with county	September 10, 2014
Flood Risk Review (FRR) meeting	September 17, 2014
FRR comment period ends	December 15, 2014
Meeting with FEMA and SCVWD, they indicated they intend to move forward with new study	February 6, 2015
SCVWD provided comments on maps	April 16, 2015
SCVWD letter to FEMA about their approach to coastal modeling	May 14, 2015
FEMA provides response letter to 4/16/2015 SCVWD comments	July 6, 2015
Preliminary FIRMs issued	July 8, 2015
SCVWD submits initial comments on 7/8/15 prelims	August 7, 2015
FEMA acknowledgement for 8/7/15 comments	August 21, 2015
Consultation Coordination Officer (CCO) meeting	September 30, 2015
Federal Register publication	February 12, 2016
2 <sup>nd</sup> newspaper publication/Appeal Start	March 17, 2016
SCVWD submits appeals (dates on coastal/riverine appeal material)	June 6 and 8, 2016, they were received on June 9, 2019
Appeal acknowledgement sent by FEMA	June 13, 2016
End 90 day appeal period	June 15, 2016
Call with FEMA and SCVWD about riverine portion of appeal submittal	January 15, 2019
Memo from STARR II to VW summarizing 65.10 review findings for the STAC levee and the Highway 237 embankment	January 17, 2019
In person meeting with FEMA and VW (their office) about status of appeals and possible paths forward	June 10, 2019
Appeal resolution letter	June 21, 2019