DOCKETED

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Project Title:	Puente Power Project
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Document Title:	Technical Memorandium Mandalay Generating Station Modeling Support
Description:	*** THIS DOCUMENT SUPERSEDES TN 219123 *** - cbec, inc. eco (cbec) has been requested by the State Coastal Conservancy (Scc) to update the previously developed MIKE FLOOD hydrodynamic model for the Santa Clara River.
Filer:	Raquel Rodriguez
Organization:	California Energy Commission
Submitter Role:	Commission Staff
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Hydrology | Hydraulics | Geomorphology | Design | Field Services

TECHNICAL MEMORANDUM

Date:	June 15, 2017
To:	Chris Kroll (SCC), Jonathon Gurish (SCC), Zooey Diggory (Stillwater)
From:	Chris Campbell, Denise Tu
Project:	17-1016 - Santa Clara River
Subject:	Mandalay Generating Station Modeling Support

1 INTRODUCTION

cbec, inc. eco engineering (cbec) has been requested by the State Coastal Conservancy (SCC) to update the previously developed MIKE FLOOD hydrodynamic model for the Santa Clara River. The model was originally developed to identify levee setback or floodplain reconnection opportunities along the Santa Clara River upstream of Harbor Blvd. The model has now been updated to more accurately characterize the potential risks of flooding at the Mandalay Generating Station (MGS) near Oxnard, CA due to a range of combined coastal and river flood conditions, to include the effects of sea level rise and climate change. More specifically, the objectives of this flood risk analysis are to:

1. Address model inundation questions posed by the California Energy Commission (CEC) on March 30, 2017 to a SCC letter dated February 6, 2017.
2. Update the 2D hydrodynamic modeling prepared by cbec/Stillwater in 2011 for SCC to better evaluate the potential risk of coastal and river flooding at the MGS to include the effects of sea level rise and changes in river flows due to climate change.

This technical memorandum is structured to address the CEC questions in Section 2, describe updates to the 2D hydrodynamic model prepared for the SCC in 2011 in Section 3, and assess the potential flood risks to the MGS under a range of combined coastal and river flood conditions.

2 RESPONSES TO CEC QUESTIONS ON 2011 MODELING GRAPHICS

The CEC posed four (4) questions to Chris Kroll on March 30, 2017 via email regarding inundation graphics submitted by SCC and CCC based on the 2D hydrodynamic modeling prepared by cbec/Stillwater in 2011 for the SCC. The questions are as follows:

1. It appears on the figure that the area of flooding cuts diagonally across parcels east of McGrath Lake. Are any walls or structures at that location to explain why flooding would stop there?
2. It also appears that Harbor Blvd floods next to McGrath Lake but does not flood next to MGS. Please explain why Harbor Blvd would flood next to McGrath Lake but not flood next the MGS.
3. Near the project site, the figure shows that the flood boundary by the ocean is green (indicating flood depths of about 10 – 16 feet) with some hints of yellow (up to about 20 feet). Please explain why the water depth next to the ocean would be 10 or 20 feet deep.
4. Please describe the assumptions that were made for the ocean water level. For example, did Stillwater Sciences assume a static water level of a specific elevation?

Please note that the purpose of the 2D hydrodynamic model, as prepared for the SCC in 2011, was to evaluate floodplain setback opportunities upstream of Harbor Blvd. It was not originally intended to evaluate in any detail flood risk downstream of Harbor Blvd. As such, the model resolution downstream of Harbor Blvd was limited in terms of its overall extent and detail. There was not a need at the time to extend it south of the MGS nor was there a need to capture waterfront features or infrastructure in detail. Answers to the four questions above are as follows:

1. Based on the general statement above regarding model extents, this linear limit of the inundation mapping east of McGrath Lake is an artifact of the 2011 model domain extents. As described in Section 3, the model has now been expanded to best capture flood impacts to the MGS to include the agricultural fields and urban areas south of West Gonzales Rd and the coastline down to Channel Islands Harbor.
2. Similar to the answer above, the linear limit of inundation mapping near MGS is an artifact of the 2011 model domain extents, which stopped short of the MGS.
3. Based on the general statement above regarding the original purpose of the model, the model was originally configured with an open boundary only along the mouth of the Santa Clara River (SCR). This limitation meant that the remaining coastline in the 2011 model was a closed boundary. As described in Section 3, the full extent of the coastline has been set to an open boundary to more accurately map inundation west of Harbor Blvd and south of the SCR Estuary.
4. The ocean boundary conditions in the 2011 model were based on a static MHHW elevation of 1.606 m without any adjustment for sea level rise for the 100-year flood event. These same conditions are included in the updated model as described as Scenario 1 in Section 4.

3 MODEL DEVELOPMENT

MIKE FLOOD is a dynamically coupled 1D/2D (MIKE 11/MIKE 21) model that can simulate the complex interplay between and amongst the river, adjacent floodplains, and the ocean. This model includes robust methods to accommodate wetting and drying of the floodplain and can readily accommodate hydraulic structures in both the 1D and 2D components of the model.

The MIKE FLOOD hydrodynamic model previously developed for the SCC in 2011 was updated to more accurately map inundation south of West Gonzalez Blvd and west of Harbor Blvd down to Channel Islands Harbor. In addition to expanding the model extents, the model boundary conditions were also updated to allow an evaluation of potential flood risks to the MGS under a range of combined coastal and river flood conditions. The following describe the model components and any updates.

3.1 MODEL DOMAIN

The 2D hydrodynamic model was originally constructed for a 40-mile reach of the SCR from the Ventura-Los Angeles County line to the Pacific Ocean in Ventura County. It was subsequently expanded south of West Gonzalez Blvd and west of Harbor Blvd down to Channel Islands Harbor (see Figure 1).

The entire river, floodplain, and coastline were represented in 2D, with only the hydraulic structures (i.e., bridge crossings) represented in 1D (see Section 3.3 for details). An unstructured 2D mesh consisting of triangular and quadrilateral elements was created for the channel and floodplain areas. Areas within the FEMA designated 100-year floodway were generally defined with triangular elements of finer resolution (15 m to 30 m element faces). Areas outside the floodway on the floodplains, upper floodplain terraces, and adjacent valley hillslopes were generally defined with triangular elements of coarser resolution (up to 100 m element faces). Important features such as roads, levees, and earthen features (i.e., berms and dunes) near the MGS were represented as “dike” features to reinforce feature crown elevations, which was important for capturing how these features impede flood flows until such time that they are overtopped.

The model was registered to UTM 11N WGS84 meters (horizontal datum) and NAVD88 meters (vertical datum).

3.2 TOPOGRAPHY AND BATHYMETRY

The digital terrain model (DTM) supporting the original 2011 model based on 2005 LiDAR was also updated (see Figure 2). The DTM was updated to reflect the best available data for the lower SCR and its coastline and was assembled from the sources listed in Table 1.

Table 1. DTM data sources

Type	Date	Source	Name	Description / Notes
Coastline				
LiDAR	2016	USGS	West Coast El-Nino LiDAR DEM	Coastline topography from elevation 3.2 m and extending approximately 0.25 miles inland
Nearshore Bathymetry				
LiDAR	2014	USACE	NCMP Topobathy LiDAR DEM	Used for nearshore bathymetry between elevations -10 m to 2m
Santa Clara River and its Floodplain				
LiDAR	2005	VCWPD	Ventura County Watershed Protection District/FEMA LiDAR	Used for the Lower SCR and its floodplain not covered by more recent datasets described above
3D polylines	2017	VCWPD	SCR-3 Phase 1 and 2 levee improvements	Levee elevations for SCR-3; elevations reinforced in the model as dike features
Santa Clara River Estuary				
LiDAR	2009-2011	NOAA	CA Coastal Conservancy Coastal LiDAR	Used for elevations above 2.68 m
Survey Points	2014	cbec	Cross sections	Used for SCRE including VWRF outfall channel
Survey Points	2012	California State University – Channel Islands (CSUCI)	Seafloor Mapping Lab 1-meter resolution, multi-beam bathymetry	Used for SCRE bathymetry
Modeled Bed Elevation	2014	cbec	MIKE21 FM sediment transport bed level 10-year flod event results from Santa Clara River Estuary Habitat Restoration and Enhancement Feasibility Study	The resulting bed level was used in the composite DTM to approximate SCRE bathymetry during an open estuary scenario during flood conditions

For consistency, all datasets were converted to UTM 11N WGS84 meters (horizontal datum) and NAVD88 meters (vertical datum).

3.3 BRIDGES

Nine bridges were included in the model throughout the 40-mile reach. Head losses through these structures were calculated in 1D in the MIKE 11 component of the MIKE FLOOD software. Hydraulic structure geometry, loss factors, hydraulic roughness, and other coefficients were left the same as used in the 2011 model. Parameter values were extracted from the FEMA (2009) restudy RAS model and used as inputs to the MIKE 11 setup. The Vern Freeman Diversion Dam was also included in the model as a broad crested weir using a dam crest elevation derived from the 2005 LiDAR dataset.

3.4 ROUGHNESS

Hydraulic roughness or Manning's n for the 2011 model was originally derived from 2005 vegetation mapping (Stillwater Sciences & URS, 2007) based on correlation to the Manning's n values from the FEMA (2009) restudy RAS model. For the expanded model domain, the 2011 National Land Cover Dataset (NLCD) was compared to the 2005 vegetation mapping to develop Manning's n values for the newly added areas (see Figure 3 and Table 2).

Table 2. Santa Clara River vegetation types, NLCD land cover and hydraulic roughness coefficients

Habitat Type	Manning's n	Habitat Type	Manning's n
Beach	0.035	Giant reed (Arundo donax)	0.055
Riverwash	0.035	Riparian Shrub (desert and mixed/willow)	0.055
Water (channel bed)	0.035	Mixed forest	0.075
Herbaceous (native and non-native)	0.040	Mixed non-native trees	0.075
Sand dune	0.040	Agriculture	0.085
Barren land	0.045	Cultivated crops	0.085
Emergent herbaceuous wetlands	0.045	Pasture	0.085
Freshwater wetland	0.045	Coastal sage scrub	0.115
Tidal Marsh	0.045	Cottonwood/willow forest	0.115
Woody wetland	0.045	Evergreen forest	0.115
Shrub/scrub	0.050	Mixed riparian forest	0.115
Disturbed	0.055	Developed	0.130

3.5 PRESENT-DAY HYDROLOGY

Hydrology for present-day conditions (i.e., 2017) was based on the boundary conditions prepared for the 2011 model. These included upstream river flows derived from a calibrated rainfall-runoff model and downstream water levels derived from published tidal datums.

3.5.1 PRESENT-DAY UPSTREAM RIVER FLOWS

Design hydrographs for the 100-year recurrence interval flood event were derived from the calibrated and validated HSPF (Hydrologic Simulation Program Fortran) model, a US Environmental Protection Agency (EPA) watershed hydrology model, developed for the Ventura County Watershed Protection District (VCWPD) and the Los Angeles County Department of Public Works (LACDPW) by AQUA TERRA Consultants (2009). Thirty-four 100-year design hydrographs were derived from the HSPF model (see Table 3).

Table 3. Hydrology summary table

Stream Name	Reach Node Name	100-year Peak Discharge (cms)	Stream Name	Reach Node Name	100-year Peak Discharge (cms)
Piru Creek	RCH529	1163.8	Haines Barranca	RCH844	83.5
Salt Canyon	RCH322	165.9	Todd Barranca	RCH852	188.3
Tapo Canyon	RCH401	124.6	Briggs Rd Drain	RCH853	34.8
Edward	RCH603	61.2	Cummings Rd Drain	RCH854	51
Warring Real Canyon	RCH605	83.8	Ellsworth Barranca	RCH862	269.6
Hopper Canyon	RCH614	552.2	Franklin Wason	RCH874	111.9
Basolo Ditch	RCH631	45.9	El Rio Drain	RCH881	29.7
Pole Creek	RCH634	209.3	Brown Barranca	RCH882	77
Sespe Creek	RCH728	3794.4	Sudden Barranca	RCH885	38.8
Reimer Ditch	RCH806	124.6	Clark Barranca	RCH886	43.6
Balcom Canyon	RCH812	130	Patterson Rd Drain	RCH891	41.1
Orcutt Canyon	RCH821	150.1	Fairview	RCH619	37.7
Timber Canyon	RCH822	142.4	Grimes	RCH641	126.6
Santa Paula Creek	RCH835	1115.7	Bear	RCH807	85.8
Fagan Canyon	RCH837	128.8	O'Leary	RCH809	106.5
Peck Drain	RCH838	51.8	Harmon	RCH883	131.1
Adams Barranca	RCH842	194.8	Santa Clara River at LA County Line	RCH320	1877.4

3.5.2 PRESENT-DAY DOWNSTREAM WATER LEVELS

In the original 2011 model, a constant water surface elevation set to mean higher high water (MHHW) was derived from NOAA tidal datums computed at that time (see Table 4). The MHHW estimate was based on the average value between the NOAA tide stations at Santa Barbara and Santa Monica.

Table 4. Existing conditions tidal datums

Datum (m, NAVD88)	Santa Barbara (ID 9411340)	Santa Monica (ID 9410840)	Average Value
MHHW	1.615	1.597	1.606
MHW	1.384	1.371	1.378
MTL	0.827	0.798	0.813
MLW	0.271	0.226	0.249
MLLW	-0.029	-0.057	-0.043

3.6 FUTURE CONDITIONS HYDROLOGY

Boundary conditions for 2050 and 2100 were prepared to account for sea level rise (SLR) and the effects of climate change on river flows. Revell Coastal provided recommendations for dynamic water level and SLR (see Appendix A). cbec prepared a simplified climate change analysis to approximate the future changes to river flows in the SCR watershed. These three components are further described below and were combined to represent future flood risks to the MGS under a range of combined coastal and river flood conditions (see Section 4.1).

3.6.1 DYNAMIC WAVE LEVEL

Please refer to Appendix A. Revell Coastal recommends using the calculations conducted by FEMA for DWL2% based on updated analysis and calculations. The average for all DWL2% levels is 3.90 m. The maximum for all DWL2% levels is 5.39 m based on the highest 100-year storm wave event (1/18/1988).

3.6.2 SEA LEVEL RISE

Please refer to Appendix A. Revell Coastal recommends using the 1 in 200 or 0.5% SLR scenarios based on the guidance from the CEC at the SLR hazard modeling workshop requesting a consideration of 0.61 m by 2050 and 2.16 m by 2100.

3.6.3 FUTURE RIVER FLOWS

To modify the present-day 100-year flood hydrographs, cbec conducted a flood frequency analysis using forecasted climate change data from Cal-Adapt. The climate scenario selected for the analysis was generated from the Centre National de Recherches Meteorologiques (CNRM) model for the Intergovernmental Panel on Climate Change (IPCC) medium-high emissions scenario Special Report on Emissions Scenarios (SRES) A2, which represents continuous population growth and uneven economic and technical growth. The A2 scenario is similar to the newest IPCC high carbon emissions scenario Representative Concentration Pathways (RCP) 8.5. The dataset used was created from downscaled data generated by global climate models used in the 4th California Climate Change Assessment. In lieu of daily runoff data for the SCR watershed, readily available monthly mean runoff data from 1950 through 2099 was acquired and processed to prepare an annual maxima series based on the maximum of the monthly mean runoff in each year. Historic conditions were defined from 1950 to 2017. Future conditions were defined from 2018 to 2099. The difference in the 1% annual chance monthly runoff for historic conditions and future conditions was used to approximate a scaling factor to modify the present-day 100-year flood hydrographs to account for climate change. Per Figure 4, the scaling factor was determined to be 1.63, which was used to uniformly scale the present-day hydrographs.

3.7 MODEL ASSUMPTIONS

The MIKE FLOOD model is a useful tool, but it is important to recognize the assumptions made in the development of the model and to understand the limitations of the modeling software. This section describes the major assumptions and limitations of the scenarios as developed for this effort:

- Continuous site topography was represented with a discrete triangular and quadrilateral mesh. Model calculations and results are generated at the scale of the mesh resolution.
- The model is a 2D depth-averaged model, meaning depth-dependent variables are characterized by a single average value.
- The model did not include any considerations for wave action, littoral transport, sediment transport, and did not simulate the initial breaching or the subsequent rebuilding of the beach.
- For all scenarios, the estuary was assumed to be open at the time of the simulation.
- The January 2005 calibration prepared for the 2011 model is still valid.
- Other known limitations pertain to uncertainty related to future climate changes and future upstream developments.

4 SCENARIO FORMULATION AND RESULTS

4.1 SCENARIO FORMULATION

To assess the potential flood risks to the MGS under a range of combined coastal and river flood conditions, the range of boundary conditions discussed in Section 3.5 and Section 3.6 were combined into a suite of six (6) scenarios as define in Table 5. Coastal boundary conditions for present-day and future conditions were provided at the recommendation of Revell Coastal based on available information and studies (see Appendix A). River boundary conditions were synthesized by cbec for present-day conditions based on a calibrated rainfall-runoff model and for future conditions by performing a climate change analysis. The scenarios were formulated to capture a suite of conditions ranging from what could be expected to occur during a 100-year flood without the effect of elevated ocean levels (Scenario 1) to a future condition with extreme coastal flooding and the 100-year flood amplified by climate change (i.e., Scenario 6).

Table 5. Scenario formulation

Scenario	Description	River Flows	Coastal Boundary
1	2017 baseline	Existing 100-year	MHHW = 1.606 m
2	2017 baseline w/ average DWL2%	Existing 100-year	Average DWL2% = 3.90 m
3	2017 baseline w/ max DWL2%	Existing 100-year	Max DWL2% = 5.39 m
4	2050 w/ CC+SLR+average DWL2%	Climate Change 100-year (existing scaled by 1.63)	SLR = 0.61 m Average DWL2% = 3.90 m Total = 4.51 m
5	2050 w/ CC+SLR+max DWL2%	Climate Change 100-year (existing scaled by 1.63)	SLR = 0.61 m Max DWL2% = 5.39 m Total = 6.00 m
6	2100 w/ CC+SLR+maxDWL2%	Climate Change 100-year (existing scaled by 1.63)	SLR = 2.16 m Max DWL2% = 5.39 m Total = 7.56 m

Notes: EC=Existing conditions; CC= climate change; DWL2% = dynamic water level; SLR = sea level rise

4.2 INUNDATION SUMMARY

These scenarios demonstrated how vulnerable the MGS is to being inundated from coastal and river flood hazards. While the MGS is not impacted by typical tidal conditions under present-day conditions, wave action during storms will impact and potentially compromise the sand dunes suggested to be protecting the MGS facilities. As coastal storm conditions worsen, the MGS would be inundated by the Pacific Ocean due to existing low spots in the sand dunes dictated by the topographic data used in the model (i.e., the sand dunes were not manually degraded nor assumed to erode during the duration of the simulation). In further combination with either present-day or future 100-year flood flows, the sand dunes along the coastline and east of Harbor Blvd play a limited role in protecting the MGS from flooding as SCR flood waters escape the river and flow south-southwest towards the MGS. Under present-day conditions considering only the impacts of the 100-year flood (i.e., Scenario 1), the MGS facilities are susceptible to inundation by up to 1.3 m. Under future conditions that consider extreme coastal flooding and the 100-year flood amplified by climate change (i.e., Scenario 6), the MGS facilities are susceptible to inundation by up to 4.0 m. Additional results by scenario are summarized below.

Scenario 1 represents present-day (i.e., 2017) conditions and simulates 100-year flood with downstream ocean conditions set at MHHW equal to 1.61 m. At MHHW, the MGS is not inundated by high tide alone. However, during the rising limb of the 100-year flood, the SCR overtops its left banks downstream of Victoria Blvd and inundates its southern floodplain. The flood waters travel south across the farm lands, overtop Harbor Blvd, and inundate McGrath Campground. At the peak of the storm, flood waters continue to flow south past McGrath Lake and inundate the MGS. Over the duration of the simulation, the maximum inundation along the north section of the MGS is up to 1.7 m with an average depth of 1.0 m.

Scenario 2 represents present-day (i.e., 2017) conditions as in Scenario 1 except that it assumes the 100-year flood occurs concurrent with an extreme storm along the Pacific Coast generating an average dynamic water level of 3.90 m. Similar to Scenario 1, the MGS inundates as SCR flood waters exit river left downstream of Victoria Blvd and travel south along Harbor Blvd. Over the duration of the simulation, maximum inundation along the north section of the MGS is up to 1.7 m with an average depth of 1.0 m.

Scenario 3 represents present-day (i.e., 2017) conditions as in Scenario 2 except that it assumes the 100-year flood occurs concurrent with an extreme storm along the Pacific Coast generating a maximum dynamic water level of 5.39 m. On the rising limb of the flood before the SCR overtops its banks, the MGS would be inundated by the Pacific Ocean due to low spots in the sand dunes. Over the duration of the simulation, maximum inundation along the north section of the MGS is up to 1.9 m with an average depth of 1.2 m.

Scenario 4 represents 2050 future conditions with a maximum SLR prediction of 0.61 m and assumes the 100-year flood with climate change occurs concurrent with an extreme storm along the Pacific Coast generating an average dynamic water level of 3.90 m. Under future climate change, the peak flood discharges increase by 50% over present-day by the time they are routed downstream to the Highway 101 bridge. Similar to the present-day scenarios, SCR flood waters exit the river downstream of Victoria Blvd and flow south towards McGrath Lake and the MGS. However, during the peak of the future flood, there are significant flood waters exiting the river near the Highway 101 and UPRR bridges, which flow southwesterly and find new pathways to the Pacific Ocean. Over the duration of the simulation, maximum inundation along the north section of the MGS is up to 2.1 m with an average depth of 1.4 m.

Scenario 5 represents year 2050 future conditions with a maximum SLR prediction of 0.61 m and assumes the 100-year flood with climate change occurs concurrent with an extreme storm along the Pacific Coast generating a maximum dynamic water level of 5.39 m. Changes in flood flows and resulting inundation patterns are similar to Scenario 4. However, over the duration of the simulation the maximum inundation along the north section of the MGS is up to 2.5 m with an average depth of 1.8 m.

Scenario 6 represents year 2100 extreme future conditions with a maximum SLR prediction of 2.16 m and assumes the 100-year flood with climate change occurs concurrent with an extreme storm along the Pacific Coast generating a maximum dynamic water level of 5.39 m. On the rising limb of the future flood before the SCR overtops its banks, the MGS would be inundated by extreme water levels in the Pacific Ocean. Changes in flood flows and resulting inundation patterns are similar to Scenario 5. However, over the duration of the simulation the maximum inundation along the north section of the MGS is up to 4.0 m with an average depth of 3.1 m.

Note: the improvements to the hydrodynamic model and the subsequent findings generated by the model are subject to revision. They were prepared to the best of our ability subject to time and budget constraints.

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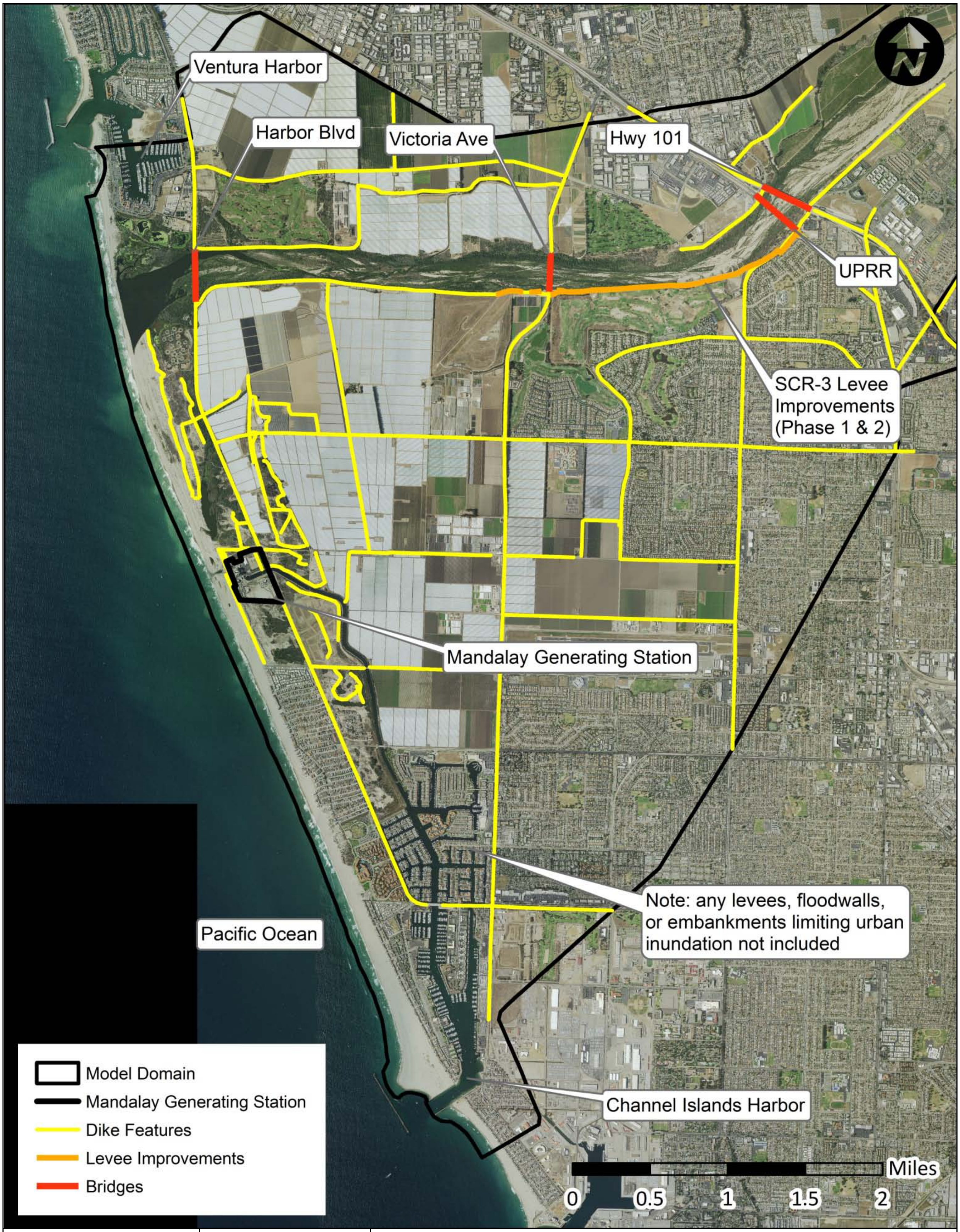

Notes: 2014 NAIP imagery

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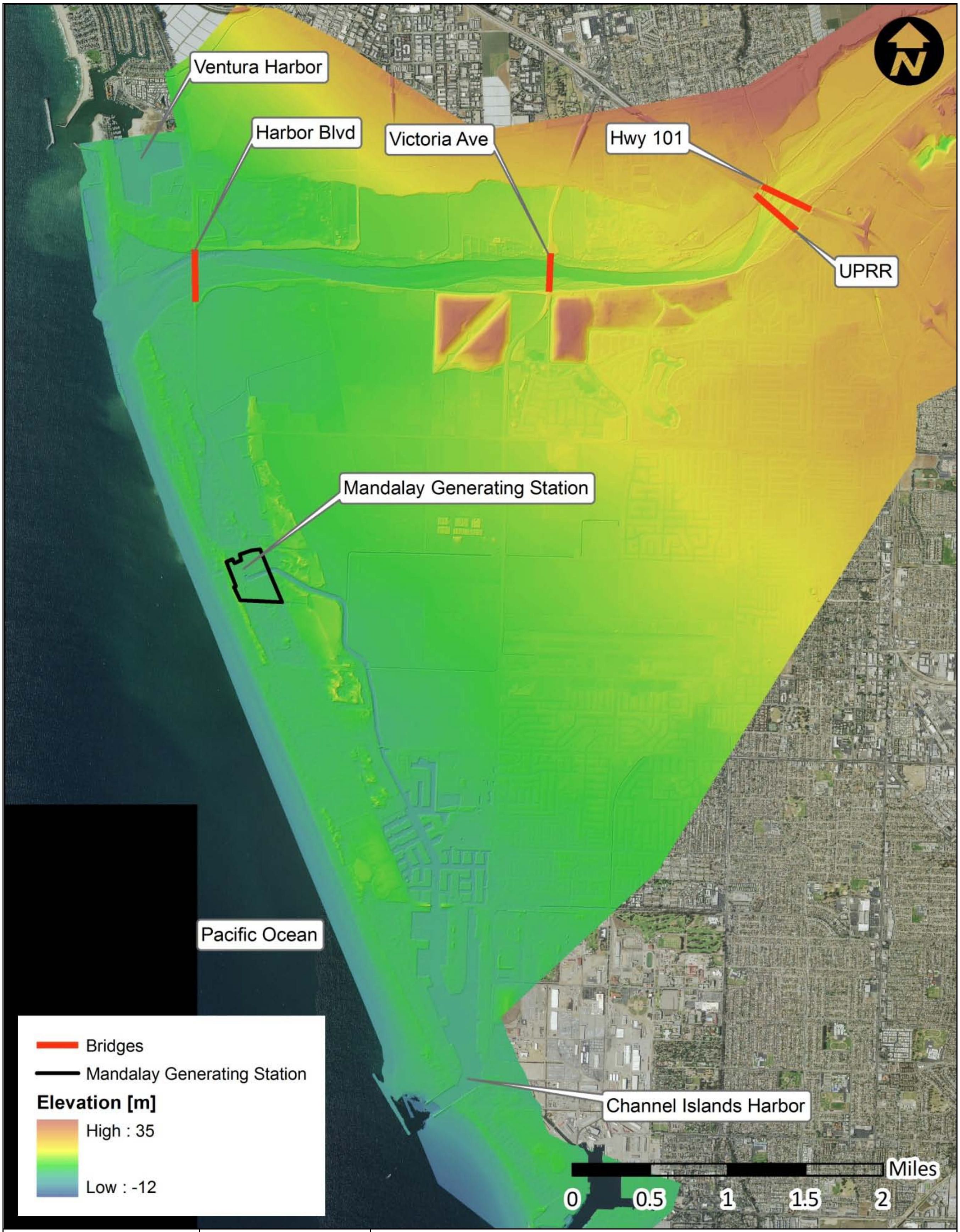
Santa Clara River Mandalay Generating Station Modeling Support

Location map and model domain

Project No. 17-1016	Created By: DT	**Figure 1**



Notes: 2014 NAIP imagery

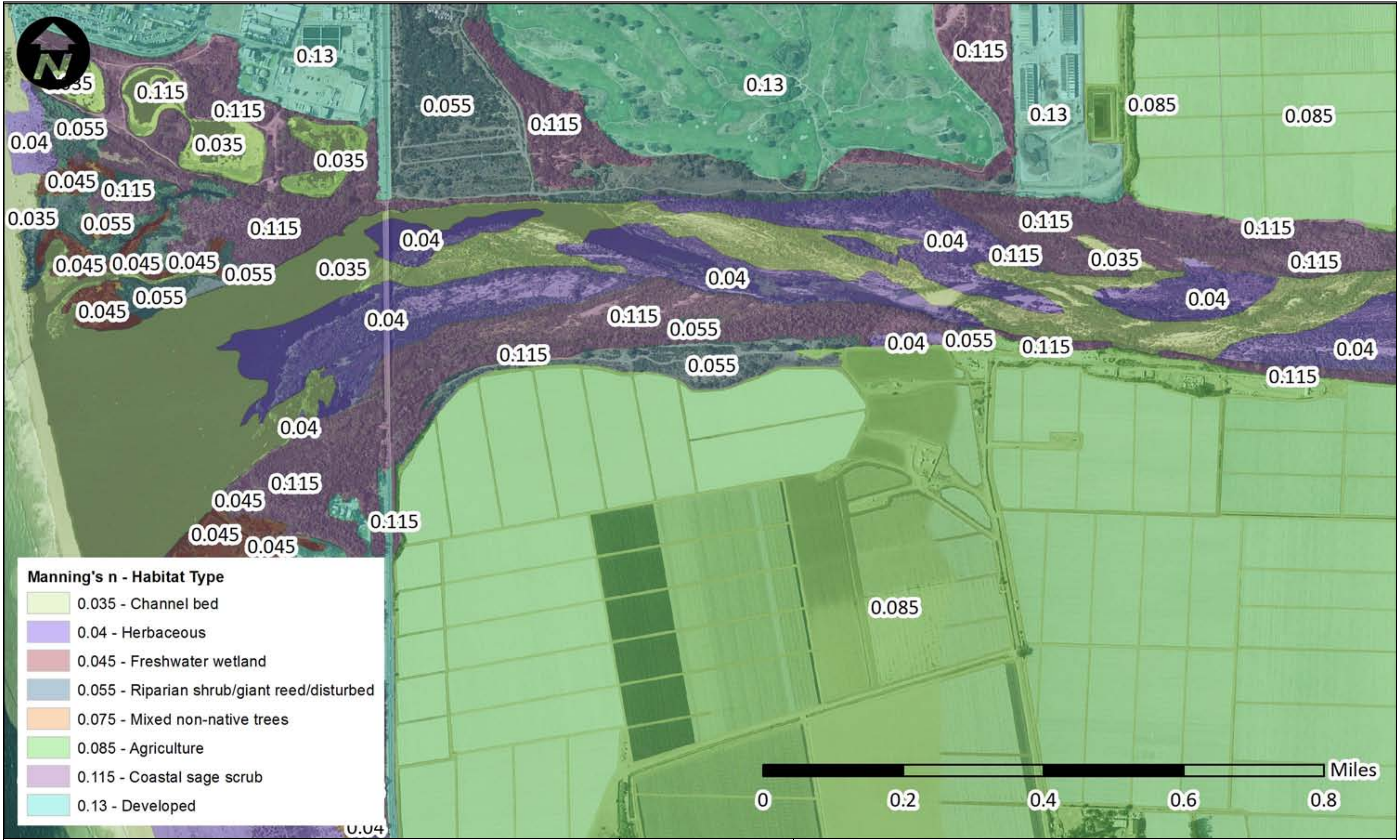
Santa Clara River Mandalay Generating Station Modeling Support

Digital terrain model

Project No. 17-1016

Created By: DT

Figure 2



Notes: 2014 NAIP imagery

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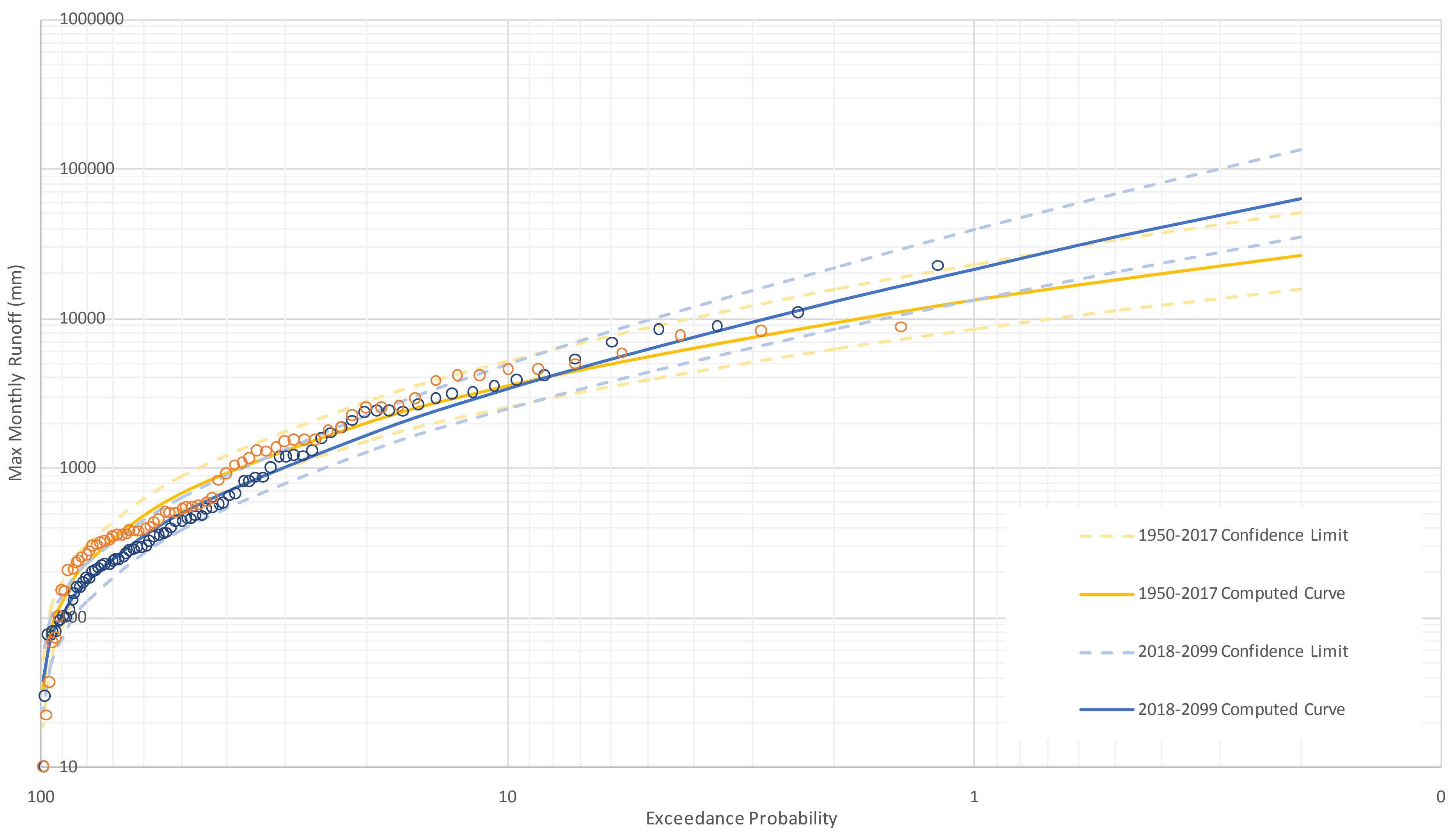
Santa Clara River Mandalay Generating Station Modeling Support

Hydraulic roughness

Project No. 17-1016	Created By: DT	**Figure 3**



Notes:

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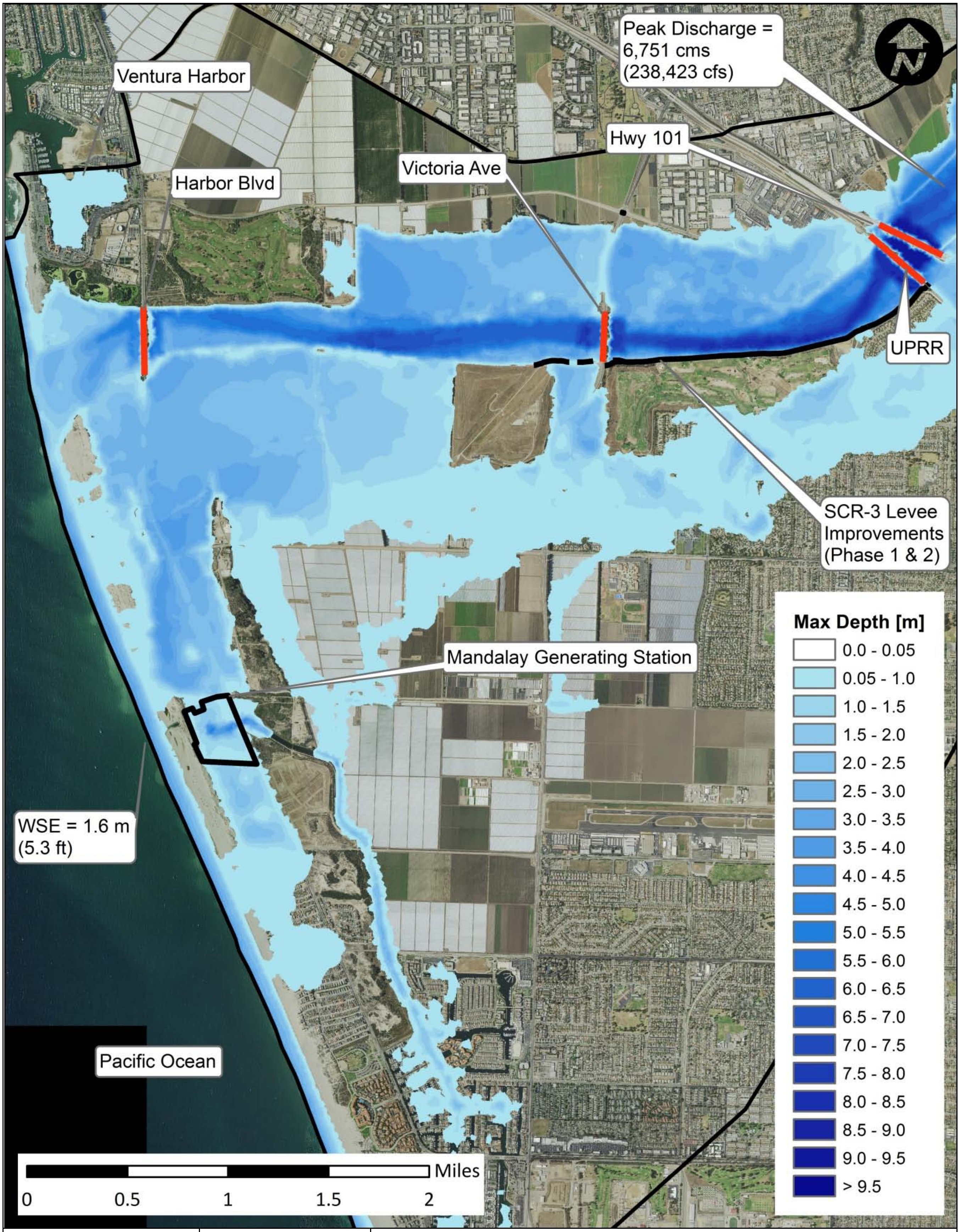
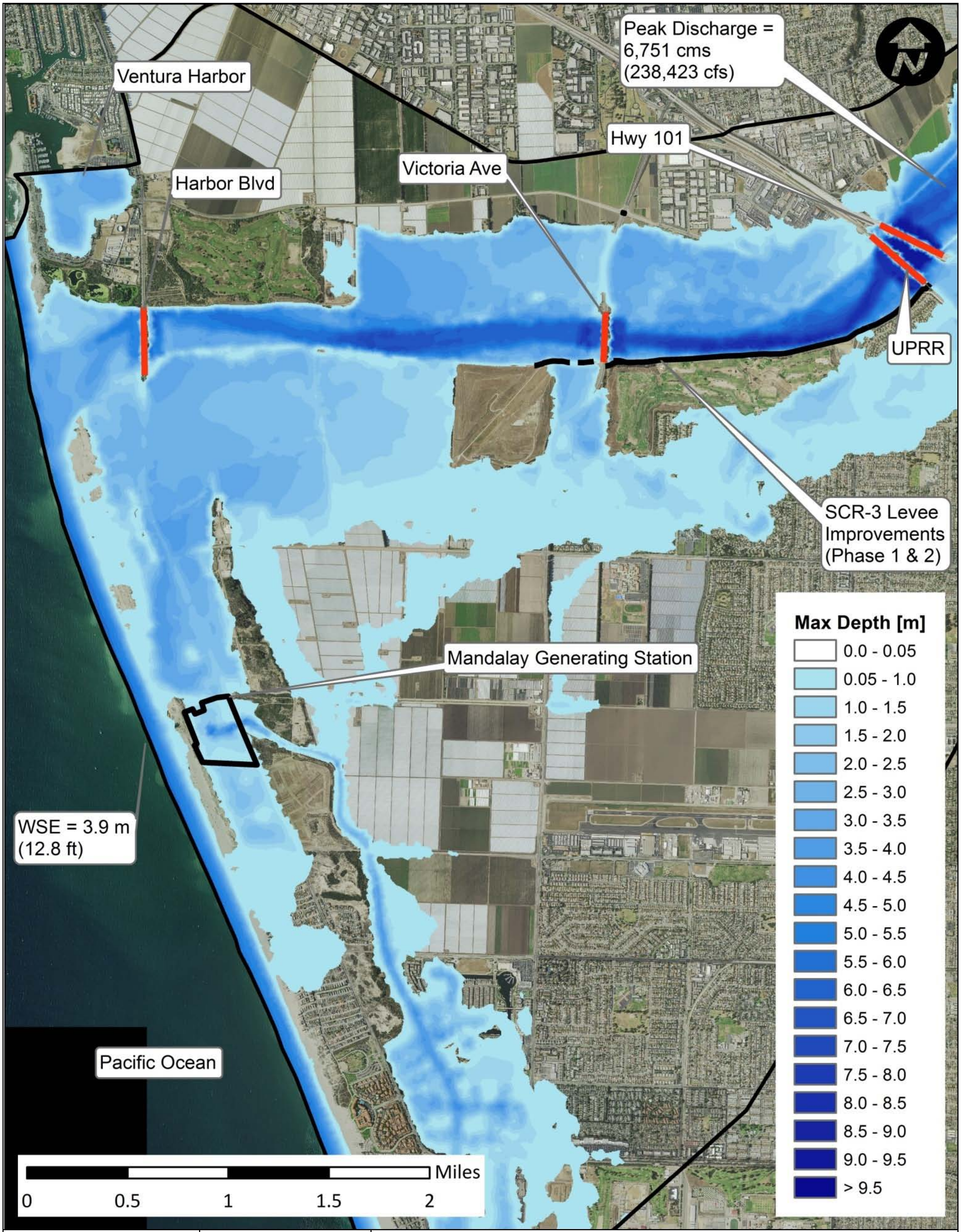
Santa Clara River Mandalay Generating Station Modeling Support

Flood frequency analysis

Project No. 17-106	Created By: DT	**Figure 4**



Notes: MHHW = 1.606 m, SLR = n/a, DWL2% = n/a	cbec eco engineering	*Santa Clara River Mandalay Generating Station Modeling Support* **Scenario 1**		
		Project No. 17-1016	Created By: DT	**Figure 5**



Notes: SLR = n/a, DWL2% = 3.9 m

Santa Clara River Mandalay Generating Station Modeling Support

Scenario 2

Project No. 17-1016

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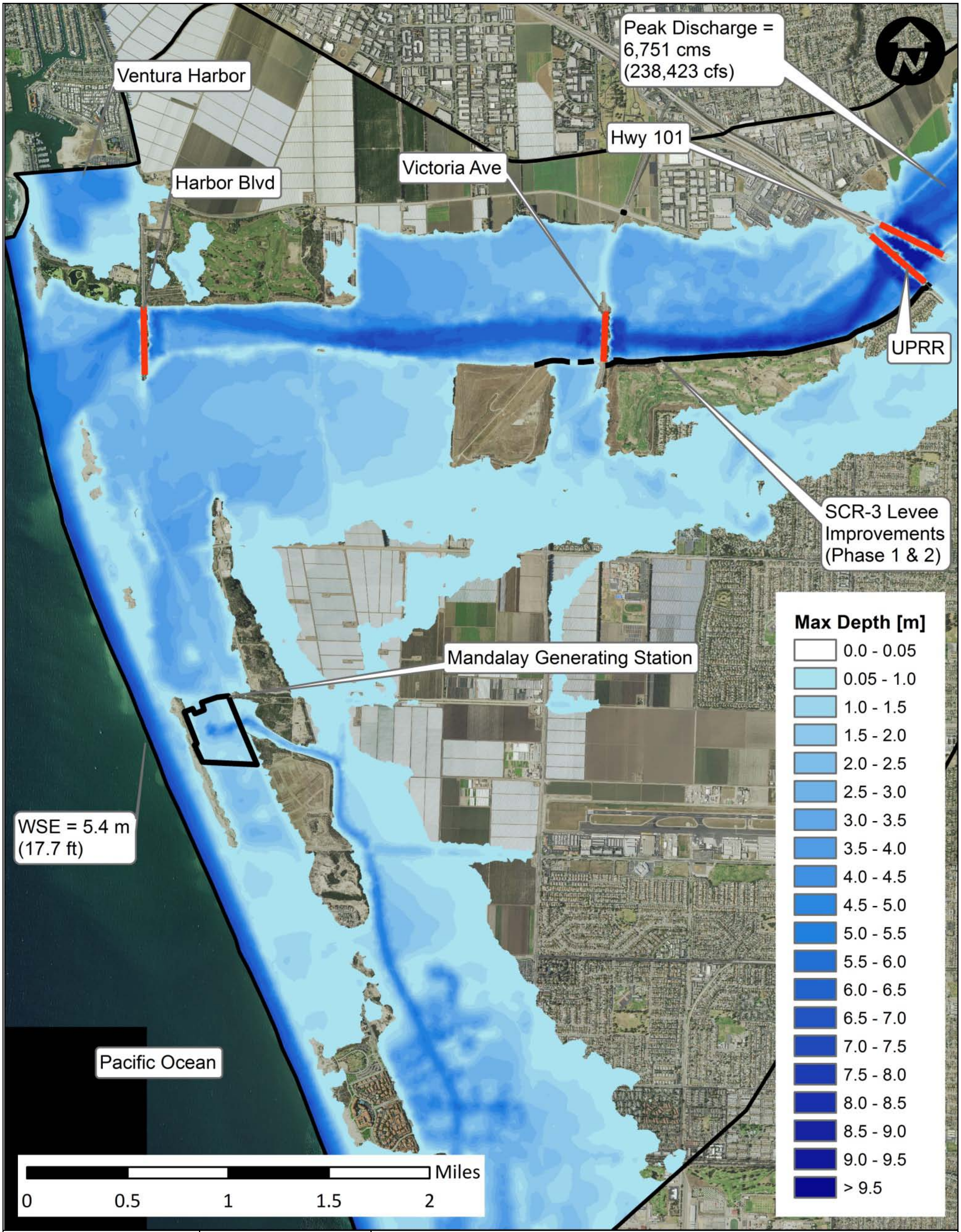
Figure 6



Notes: SLR = n/a, DWL2% = 5.39 m

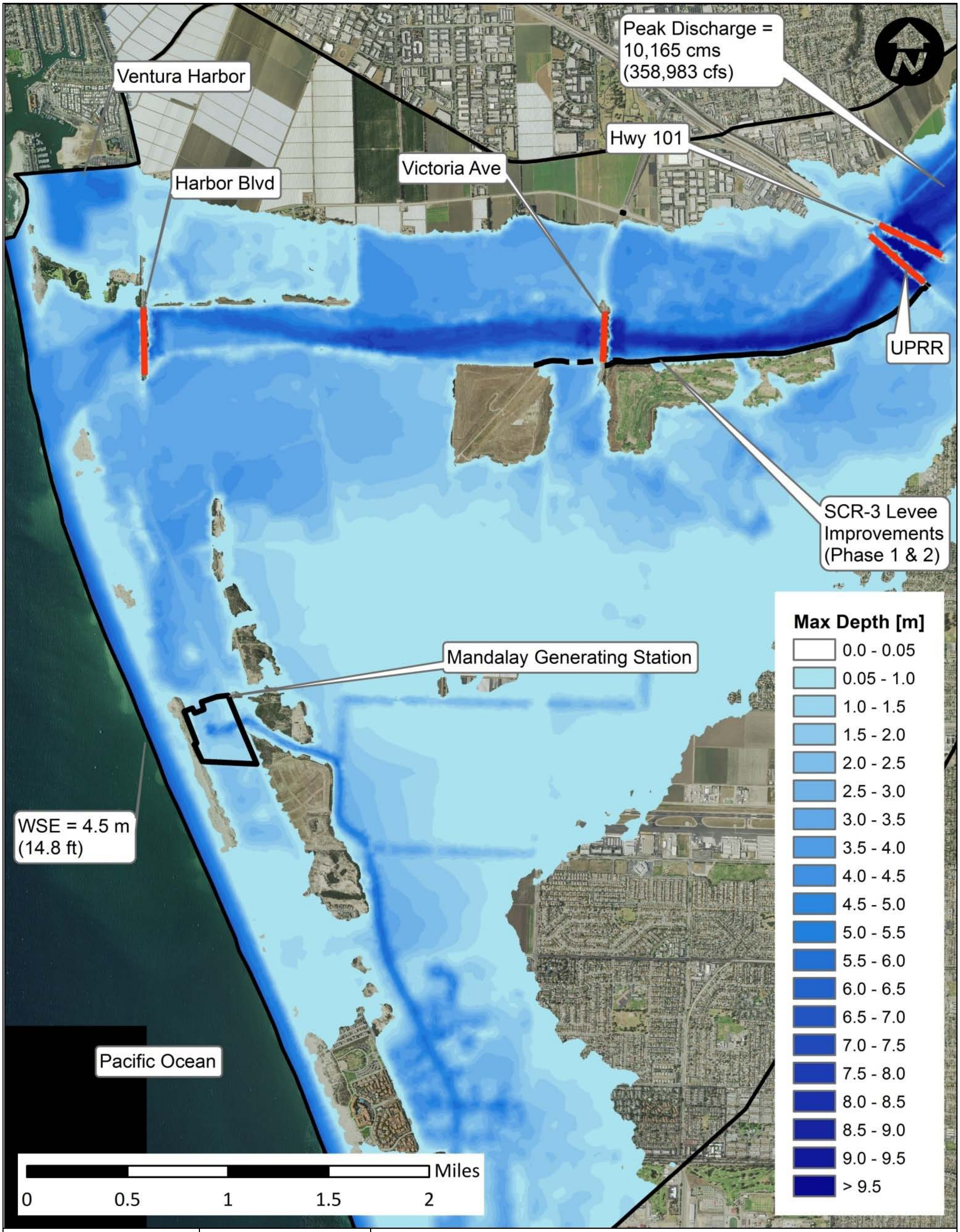
Santa Clara River Mandalay Generating Station Modeling Support

Scenario 3

Project No. 17-1016

Created By: DT

Figure 7



Notes: SLR = 0.61 m, DWL2% = 3.90 m

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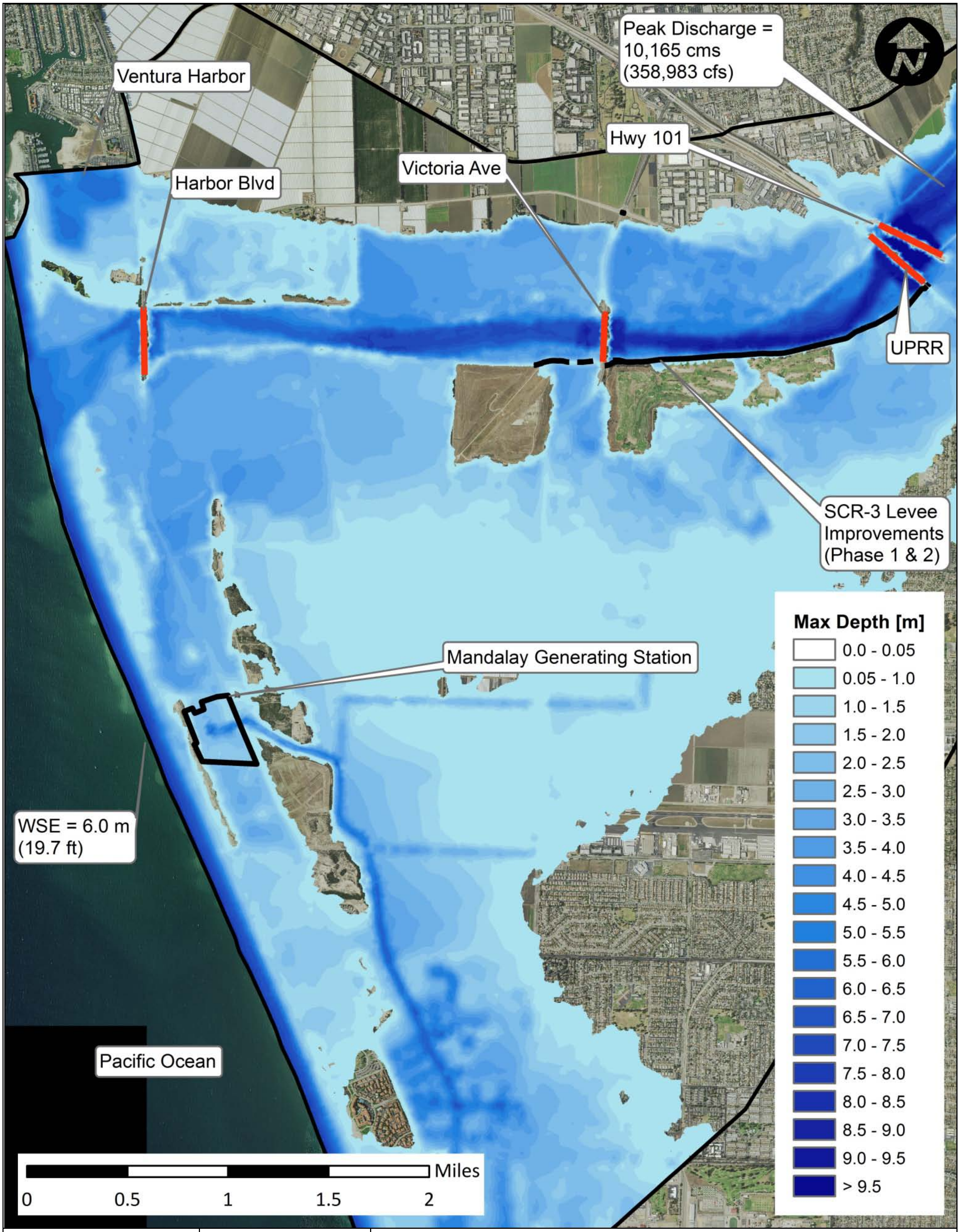
Santa Clara River Mandalay Generating Station Modeling Support

Scenario 4

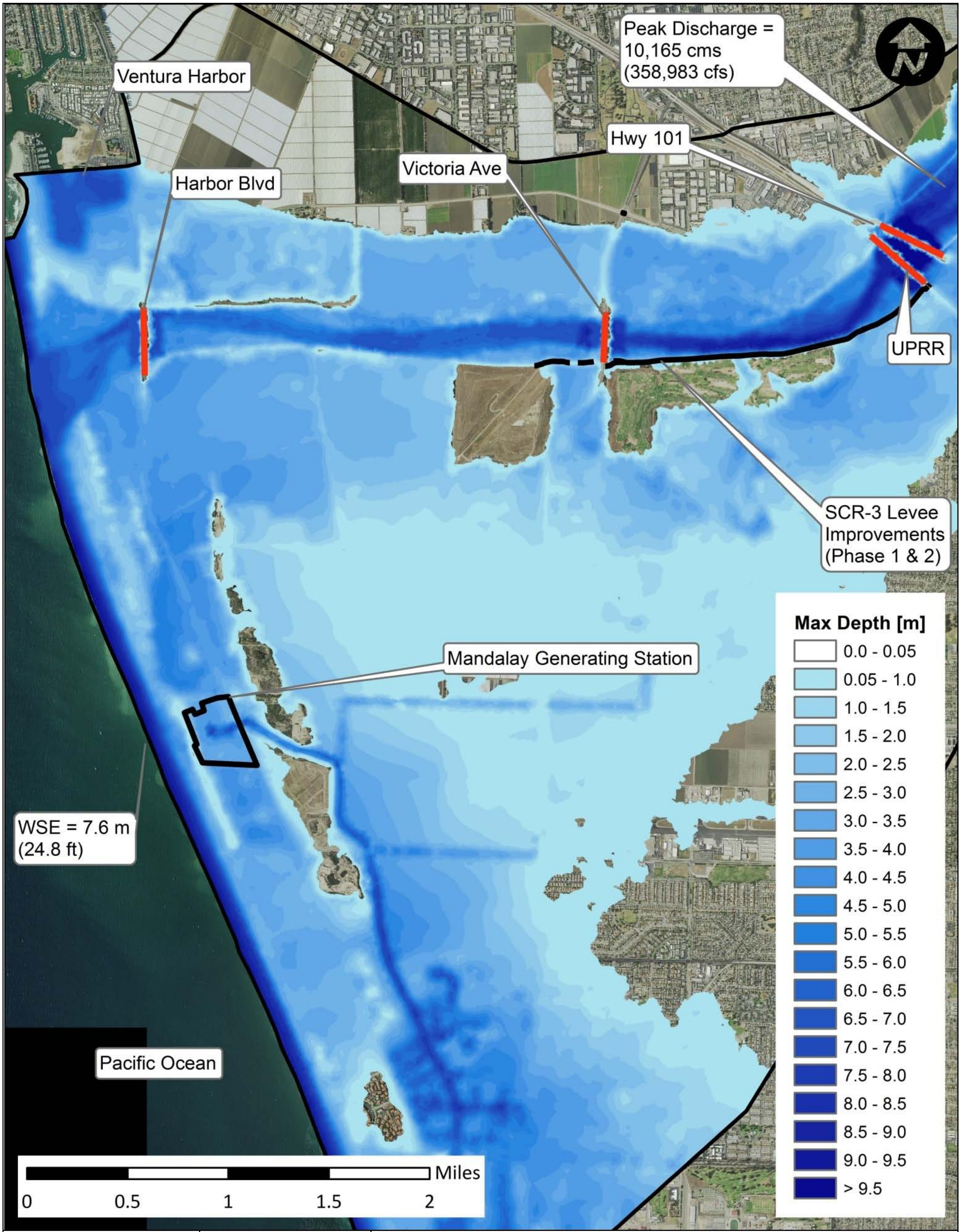
Project No. 17-1016

Created By: DT

Figure 8



Notes: SLR = 0.61 m, DWL2% = 5.39 m	cbec eco engineering	*Santa Clara River Mandalay Generating Station Modeling Support* **Scenario 5**
	Project No. 17-1016	Created By: DT **Figure 9**



Notes: SLR = 2.16 m,
DWL2% = 5.39 m

cbec
eco engineering

Santa Clara River Mandalay Generating Station Modeling Support

Scenario 6

Project No. 17-1016

Created By: DT

Figure 10

APPENDIX A

OCEANIC BOUNDARY CONDITIONS RECOMMENDATIONS

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Surf. Sand. Sustainability.

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MEMORANDUM

Date: May 18, 2017

To: Chris Campbell

From: David Revell, PhD

Subject: Oceanic Boundary Conditions for SCR

Purpose

Summarize the range of potential values to utilize for the oceanic boundary conditions for the Mike21 modeling on the Santa Clara River (SCR).[1] It is recommended that CBEC utilize a dynamic wave set up water level (DWL2%) similar to the Coastal Resilience Ventura and COSMOS 3.0 approach to coastal confluence flooding.

Definition

Dynamic wave setup – a portion of wave run-up that contribute significantly to damage potential of waves. The dynamic wave setup component is larger for narrower wave spectra and is substantial on the Pacific Coast during extreme storms. The dynamic setup is an oscillatory type of infragravity wave (periods >90 seconds) and can carry floating debris such as logs at high velocities and thus increase the hazards and damage potential in coastal areas. (excerpt from FEMA 2005).

Coastal Resilience Ventura

For the coastal confluence modeling on the Santa Clara River, a dynamic wave set up water level + 1' escalated with sea level rise was utilized. For their modeling the following ocean water levels were assumed (ESA PWA 2013)

	SLR	DWL2%
2030	**0.75**	**12.7**
2060	**1.0**	**14.2**
2100	**4.8**	**16.7**

FEMA

FEMA as part of their preliminary FIRM mappiong work for Ventura County calculates a dynamic water level surface (DWL2%) for the top 133 historic storm events. Results below are based on FEMA contractor calculated results for transect 45 (analysis transect VE383) the closest to the mouth of the SCR. from the IDS3 Technical Appendix D.

DWL2% values range from 17.7 feet for the highest 100 year storm wave event (1/18/1988).
The average for all DWL2% levels is 12.8ft and the range is 17.7ft to 11.9ft.

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[1] All elevation values are relative to NAVD88

COSMOS

COSMOS 3.0 FINAL is recently available for Ventura County but will take some time to get through the ~30 GB of data for the site. Should I proceed on this?

Sea Level Rise

Sea level rise projections and the science around climate change is constantly evolving. The latest scientific synthesis for the State of California describes a range of regional SLR projections that have some probabilistic assessments including a 50%, 5% and 0.5% probability (Griggs et al 2017). The closest regional projection comes from the La Jolla tide gage and are summarized below (excerpt Griggs et al 2017 Table 1c).

	50% (1 in 2)	5% (1 in 20)	0.5% (1 in 200)
2030	**0.5**	**0.7**	**0.9**
2050	**0.9**	**1.4**	**2.0**
2100 (RCP 8.5)	**2.6**	**4.6**	**7.1**

Recommendations

Revell Coastal recommends using the 1 in 200 or 0.5% SLR scenarios based on the guidance from the CEC at the SLR hazard modeling workshop requesting a consideration of 2.0 ft by 2050.

For the DWL2% assumption, Revell Coastal recommends using the calculations conducted by FEMA for DWL2% which are relatively consistent with the Coastal Resilience Ventura but have included updated analysis and calculations.

Revell Coastal recommends that scenarios of stream flow changes should be tied to the latest 4th California Climate Assessment projections of precipitation changes.

Two recommended scenarios (all elevations in feet NAVD)

	SLR	DWL2%	Total
2017	**0**	**17.7**	**17.7**
2030	**0.9**	**17.7**	**18.6**
2050	**2.0**	**17.7**	**19.7**
2100	**7.1**	**17.7**	**24.8**

	SLR	DWL2%	Total
2017	**0**	**12.8**	**12.8**
2030	**0.9**	**12.8**	**13.7**
2050	**2.0**	**12.8**	**14.8**
2100	**7.1**	**12.8**	**19.9**

References

ESA PWA 2013. Coastal Resilience Ventura Technical Report for Coastal Hazards Mapping, prepared for the Nature Conservancy. San Francisco, CA, July 31, 2013.

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FEMA 2005. "Final Draft Guidelines: Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States." Prepared for the U.S. Department of Homeland Security.

FEMA 2016. Intermediate Data Submittal #3. Nearshore Hydraulics Ventura, CA FEMA Region 9. Appendix D. April 21, 2016. Contractor BakerAECOM for FEMA Region 9.