RANSOM
Consulting, Inc.

Memo

400 Commercial Street, Suite 404, Portland, Maine 04101, Tel (207) 772-2891, Fax (207) 772-3248
Byfield, Massachusetts □ Portsmouth, New Hampshire □ Hamilton, New Jersey □ East Providence, Rhode Island
www.ransomenv.com

Date: December 9, 2013
To: Travis Kennedy, Senator King's office
From: Bob Gerber
Subject: Issues I would like to resolve with FEMA prior to start of the Appeal Period in York and Cumberland Counties in Maine

As requested by you, I have summarized below the issues I would like to discuss in person with FEMA and/or STARR prior to the start of the Municipal Appeal period for York and Cumberland Counties in Maine:

1. An interpretation of wave profile data and flood map data where a flood zone of a specific Base Flood Elevation stops on the seaward side of where the flood elevation meets the ground surface. See **Attachment 1** where the Wave Profile CM-026 example from FEMA documents illustrates the problem in a cross section view. Werner Gilliam of Kennebunkport has said that he has noticed a number of cases in Kennebunkport where the flood zone of, say 14', over a ground elevation of 12'. A few other examples I picked at random from FEMA's wave profiles include YK-114, YK-126, CM-001, CM-013, CM-026, and CM-054. The question is: how are these situations interpreted?
2. Documentation for the new wind velocities that are used in both the STWAVE and CHAMP models which are different from what were used in Cumberland and York Counties in the 2009 TSDN. I do not find any documentation or statistical analysis of where these wind velocities come from.
3. Documentation for the new offshore boundary condition wave heights and periods that are used in the new STARR STWAVE models that are different from what was documented in the 2009 TSDN.
4. Explanation of what the various wave spectra are that are included in the FEMA's STWAVE models and an identification of which wave spectrum was used in the STARR STWAVE model simulations that were used to derive incident wave conditions, such as the one for Casco Bay.
5. CHAMP model data sets for the Town of Freeport: I cannot find them in the model data discs that were provided.
6. A final single table showing what decisions were made for the engineering calculations for each wave transect. The spreadsheet provided on the "coastal deliverable" discs has multiple tabs, not all pertinent data are summarized, and it is difficult to know what the final choices were. It would be really helpful to provide a table such as in the fragment of the attached Excel spreadsheet from the Plymouth

County, MA, engineering summary (**Attachment 2**). A table of this type would also help in deciphering what is going on with the types of wave envelopes discussed in Item 1, above.

7. Note to STARR: The projections that were assigned to several of the ArcGIS shapefiles in the "Spatial" directory (of, I think, York County) were specified as UTM when in fact they were Maine State Plane West in feet.
8. In working on the appeals for Scarborough and Old Orchard Beach I noticed that the incident wave heights used to calculate setup and used in the CHAMP models were the offshore wave characteristics used as boundary conditions for STARR's STWAVE model. This means that the STWAVE model was not even needed. When the Municipal Appeal periods for York and Cumberland Counties were terminated in mid-appeal period in 2010, it was my understanding that in re-doing the floodmaps, one of the main improvements would be to construct and use an STWAVE model (or some similar 2-D model) to choose incident wave heights and periods for the selection of incident wave heights and periods in all of the York and Cumberland County municipalities besides the ones I had already calculated and presented to FEMA and which have been incorporated into the new maps. The question is: why wasn't this method used for the rest of York and Cumberland Counties?

To show what has actually transpired with the new Preliminary Floodmaps for York and Cumberland Counties, I have chosen a transect from each of the towns I represented in 2010 and sent calculations to FEMA then, and contrasted them with transects from Old Orchard Beach and Scarborough (neither of which I provided any new calculations to FEMA).

The table below summarizes the comparisons of before and after for those towns I submitted re-calculated data in 2010 using STWAVE to choose incident wave height:

New T #	Old T#	New Hs	Old Hs	New Setup	Old Setup
YK-90	KB-3	14'	22'	3.0'	3.6'
YK-97	KP-14	12'	22'	2.2'	3.3'
YK-117	BD-12	20'	22'	3.2'	3.5'
CM-31	CE-4	22.3'	26.6'	5.8'	6.3'
CM-39	SP-2	2.8'	7.1'	1.2'	2.8'
CM-53	PL-11	5.7'	26.6'	2.0'	6.4'
CM-127	HW-35	3.2'	26.6'	1.5'	6.1'

Note: Offshore boundary condition Hs (significant) wave heights for York County in 2009 was 22'; offshore boundary Hs for Cumberland County was 26.6'

For Old Orchard Beach and Scarborough, the table below summarizes the comparisons of what FEMA provided in 2009 versus 2013:

New T #	Old T#	New Hs	Old Hs	New Setup	Old Setup
YK-139	OB-6	42.65'	22'	4.1'	3.1'
CM-004	SB-12	29.9'	26.6'	3.1'	2.9'

Note: Offshore boundary condition Hs (significant) wave heights for York County in 2013 appear to be 42.65'; offshore boundary Hs for Cumberland County appears to be 29.9'

One can see from the above that for the towns that I re-calculated in 2010, the incident wave height was taken from my STWAVE models and was always less than the offshore boundary condition wave height. FEMA had always used the offshore boundary wave height to calculate wave setup in 2009. Therefore, the setup that FEMA calculated in 2013 was less than what they calculated in 2009 for the towns in which I submitted recalculated incident wave heights

For Old Orchard Beach and for Scarborough, in *both* 2009 and in 2013 FEMA used the offshore boundary condition wave height without attenuation at the shoreline to calculate wave setup. The only differences between 2009 and 2013 FEMA wave setup calculations are than FEMA apparently came up with new offshore boundary condition wave heights and periods, although I cannot find the documentation for this change anywhere in the FEMA material provided to the Towns to date.

Attachments 3-9 come from the new 2013 FEMA transect attribute tables for Kennebunk, Kennebunkport, Biddeford, Cape Elizabeth, South Portland, Portland, and Harpswell. These are the towns for which I provided re-calculated transects in 2010. Attachment 6A is from FEMA's new draft FIS Table 11 with CM-031 transect highlighted. Although I recalculated Falmouth's transects in 2010, FEMA had only redelineated Falmouth's transect results in 2009.

Attachment 10 is the 2013 FEMA transect attribute table for YK-139 (OB-6) in Old Orchard Beach and clearly shows that in both 2009 and 2013 FEMA used the offshore boundary condition wave to calculate setup. **Attachment 11** is the 2013 WHAFIS input for CM-004 (SB-12). This again clearly shows that the new undocumented offshore wave boundary condition was used to calculate the setup for this transect that goes into Scarborough Marsh both in 2009 and in 2013, with the wave height increased in 2013 from 26.6' to 29.9'.

As for the effect this difference in incident wave height makes in the calculation of the estuarine total water level and wave heights, as calculated through WHAFIS, I have provided an example with the Scarborough CM-004 (SB-12) transect that goes through the entrance to Scarborough Marsh.

Attachment 11 is a map of FEMA's STWAVE model-predicted wave heights in meters. The contour interval is 0.5 meter and I have indicated where the 3.5 meter contour line lies. FEMA did not use the results of the STWAVE model but I did in my calculations as you will see below. I have also shown the location of the wave transects and labeled the three closest to the mouth of the Scarborough River.

Attachment 12 is FEMA's MathCAD calculations of wave setup for CM-004. The incident wave height used is 29.9 feet for all Scarborough transects. In 2009, 26' was used. There is no documentation on the disc you gave me as to how this

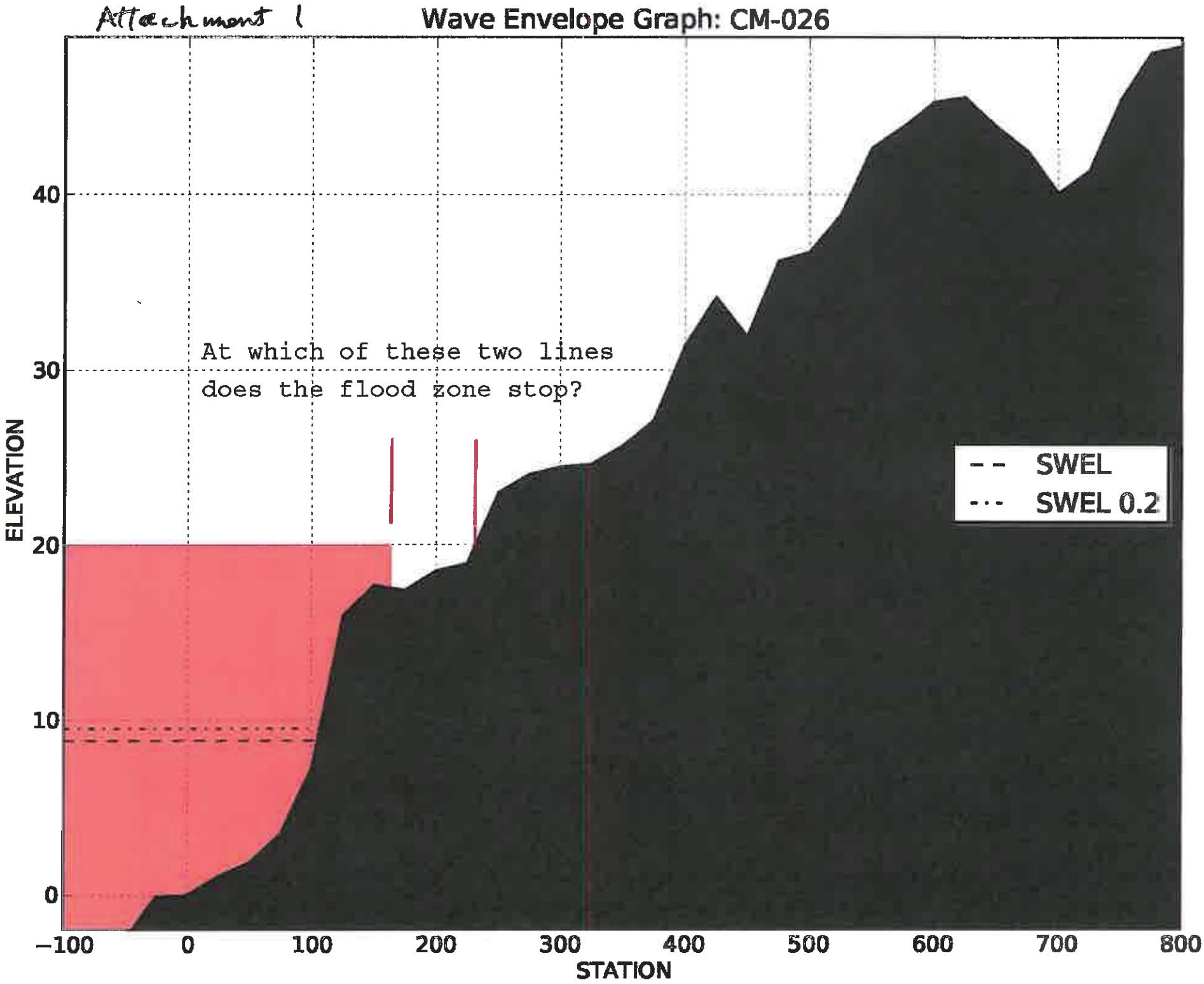
new height was derived. Notice that on Attachment _ the wave setup for the mouth of the Scarborough River is calculated to be 3.1 feet.

Attachment 13 is the FEMA table of output flood zones and BFE's calculated by WHAFIS from the baseline station of 0.0', which is located where the transect crosses the 0.0' NAVD88 ground contour. These elevations represent the elevation of the top of the wave crests for the average of the 1% highest waves during the two hours that span the peak of the 100-year storm (also called the "critical wave height", or Hc). Notice there are zones with elevations 13', 14', and 15' behind the entrance to the marsh.

Attachment 14 is FEMA's CHAMP model graphic output of the cross section of the calculated flood zones and elevations. This is a profile view looking northwest. Notice the blue line (wave setup on top of surge) that is located 3' higher than the SWEL (surge elevation). The upper green and red lines are the plot of the calculated "wave profile". It is green in the AE zones and red in the VE zones. Notice how the wave enters the River at 1' high, then eventually builds to just over 3' high, so the critical wave crest elevations step up from elevation 13' to 15'.

Attachment 15 is my calculation of the wave setup on transect CM-004 (SB-12), using the same methodology I used on the rest of southern Maine which has been accepted and incorporated in the new maps. So I use a wave height of 11.5' (taken from FEMA's STWAVE model as shown on **Attachment 11**) and the calculated wave setup is 1.5', or 1.6' less than FEMA's. Then I change the inputs to FEMA's CHAMP model to reflect the changed wave height and wave setup and run the model and produce my run of WHAFIS as shown on **Attachment 16**. For the purposes of this illustration only I used the same wind velocity used by FEMA of 60 mph, although I had calculated a 100-year wind 1-hour wind velocity of 52.3 mph which was accepted and applied in the rest of Cumberland County towns I recalculated in 2010. So my newly calculated BFEs for the marsh on CM-004 (SB-12) are now 11' going up to 12' and all are AE zones.

Attachment 1



Sample Table taken from Plymouth County, MA, showing wave transect decisions

Attachment 2

TRANSECT ID	Open / Restricted	Fetch Length (mi)	Wind Speed (m/s)	SWEL	Wave Height	Wave Period	Wave Length	H_b	d_b	Average Transect Slope				
										Toe / Breaking Wave Height Elevation	Top / SWEL Elevation	Toe Station	Top / SWEL Station	Average Transect SLOPE, m
PL-29				9.5	30.65	10.65	*581.2664*	*24.8*	*31.8*	*-22.3*	*9.5*	*-8956.39*	*997.14*	*0.00319*
PL-30				10.3	30.65	10.65	*581.2664*	*24.8*	*31.8*	*-21.5*	*10.3*	-1904.15	768.51	*0.01188*
PL-31				10.3	30.65	10.65	*581.2564*	*24.8*	*31.8*	*-21.5*	*10.3*	-694.9	50.98	*0.04257*
PL-32				10.3	30.65	10.65	*581.2564*	*24.8*	*31.8*	*-21.5*	*10.3*	-637.93	100.64	*0.042992*

Sample Table taken from Plymouth County, MA, showing wave transect decisions

Attachment 2

		Average Shore Slope		Wave Setup			Wave Runup			Structure Analysis		
TRANSECT ID	1:ON	Average Beach Slope	1:ON	Open, h_{open} (ft)	With Structure $h_{structure}$ (ft)	Total Water Level	Runup 2% (ft)	Method	Overtopped?	Does Structure Exist?	Revetment or Vertical Structure?	Toe Station (ft)
PL-29	*313.474*	0.009527	*104.9621053*	2.8		12.3	0.52	Runup 2.0		No		
PL-30	*84.1721*	0.013403	*74.61262136*	3.64	3.65	13.95	5.89	Runup 2.0		Yes	Revetment	115.46
PL-31	*23.4906*	0.20204	*4.949514563*	4.7	5.93	16.23	11.12	TAW	No	Yes	Natural Rock	10
PL-32	*23.2603*	0.102345	*9.770873786*	4.71	6.89	17.19	18.48	TAW	Yes	Yes	Revetment/Seawall	-4.82

Sample Table taken from Plymouth County, MA, showing wave transect decisions

Attachment 2

			Failed Structure Analysis						Notes on Engineering D				
TRANSECT ID	Top Station (ft)	Armor Depth (ft)	Failed Structure Top Station (ft)	Failed Structure Top Elevation (ft)	hFailedStructure (ft)	Runup 2% (ft)	Method	Overtopped ?	SURVEY	SWEL/TWEL	STRUCTURE	FAILURE	EROSION
PL-29											No	No	No
PL-30	125.46	4	134.73	14.27	4.47	5.89	Runup 2.0				Yes	Yes	No
PL-31	98	4							Yes		Yes	No	No
PL-32	107.18								Yes		Yes	No	No

Sample Table taken from Plymouth County, MA, showing wave transect decisions

Attachment 2

	ecisions					
TRANSECT ID	RUNUP INTACT	RUNUP FAILED	WHAFIS INTACT	WHAFIS FAILED	General **Notes**	Run-Up Notes
PL-29	Yes	No	Yes	No		
PL-30	Yes	No	Yes	Yes		
PL-31	No	No	Yes	No		
PL-32	No	No	Yes	No	Not subject to failure, since seawall backed by a revetment	

Attachment 3

2013_S_Cst_Tsct_Ln
23031C

Kennebunk old KB-3

Location: 379,073.410 4,799,883.052 Meters

Field	Value
TRAN_LN_ID	YK-090
TBASELN_ID	90
TRAN_NO	90
METHOD	TOPO AND SURVEY
XCOORD	2866108.91899
YCOORD	186726.866904
WTR_NM	Atlantic Ocean
V_DATUM	NAVD88
DATUM_CONV	0
CSTLN_TYP	Open Coast
BEACH_SET	NON-ERODIBLE COASTAL CLIFFS AND BLUFFS
CST_MDL_ID	1
EVENT_TYP	1 PERCENT CHANCE
SWEL	8.9
SIG_HT	14 old 22'
SIG_PD	11.1
CON_HT	0
CON_PD	0
MEAN_HT	0
MEAN_PD	0
FETCH_LEN	0
FTCHLNUNIT	FEET
EROS_METH	NOT APPLIED
LOC_DESC	The transect crosses a mixed substrate beach on Kennebunk Beach, ther
LU_SOURCE	AERIAL
RUP	12.8

Setup 3' old 3.6'

Attachment 4

2013_S_Cst_Tsct_Ln
23031C

Kennebunkport old KP-14

Location: 382,849.551 4,800,653.520 Meters

Field	Value
TRAN_LN_ID	YK-097
TBASELN_ID	97
TRAN_NO	97
METHOD	CUT FROM TOPO
XCOORD	2877628.79574
YCOORD	189054.891895
WTR_NM	Atlantic Ocean
V_DATUM	NAVD88
DATUM_CONV	0
CSTLN_TYP	Open Coast
BEACH_SET	NON-ERODIBLE COASTAL CLIFFS AND BLUFFS
CST_MDL_ID	1
EVENT_TYP	1 PERCENT CHANCE
SWEL	8.9
SIG_HT	12 old 22'
SIG_PD	11.1
CON_HT	0
CON_PD	0
MEAN_HT	0
MEAN_PD	0
FETCH_LEN	0
FTCHLNUNIT	FEET
EROS_METH	NOT APPLIED
LOC_DESC	The transect crosses over a mixed substrate beach with bedrock bluffs,
LU_SOURCE	AERIAL
RUP	20.3

Setup [redacted] 2.2' old [redacted] 3.3'
[redacted]

Attachment 5

2013_S_Cst_Tsct_Ln
23031C

Biddeford old Transect BD-12

Location: 388,657.696 4,808,383.602 Meters

Field	Value
TRAN_LN_ID	YK-117
TBASELN_ID	117
TRAN_NO	117
METHOD	CUT FROM TOPO
XCOORD	2896751.31032
YCOORD	214284.298319
WTR_NM	Atlantic Ocean
V_DATUM	NAVD88
DATUM_CONV	0
CSTLN_TYP	Open Coast
BEACH_SET	NON-ERODIBLE COASTAL CLIFFS AND BLUFFS
CST_MDL_ID	1
EVENT_TYP	1 PERCENT CHANCE
SWEL	8.9
SIG_HT	20 old 22'
SIG_PD	11.1
CON_HT	0
CON_PD	0
MEAN_HT	0
MEAN_PD	0
FETCH_LEN	0
FTCHLNUNIT	FEET
EROS_METH	NOT APPLIED
LOC_DESC	The transect crosses over rocky shoreline at Fortunes Rocks then extenc
LU_SOURCE	AERIAL
RUP	9.9

Setup 3.2' old setup 3.5'

Attachment 6

S_CST_TSCT_LN
CM-031

Cape Elizabeth
Old Transect CE-4

Location: 2,940,510.914 285,371.888 Feet

Field	Value
FID	118
Shape	Polyline
TRAN_LN_ID	CM-031
TRAN_NO	031
CST_MDL_ID	34
SETUP_DPTH	5.8
SIG_HT	22.3
SIG_PD	12.2
CON_HT	58
CON_PD	-9999
MEAN_HT	16.7
MEAN_PD	12.2
SOURCE_CIT	STUDY1
EROS_METH	NOT APPLIED
TIME_UNIT	Seconds
V_DATUM	NAVD88
LEN_UNITS	Feet
VZONE_EXT	RUNUP
METHOD	CUT FROM TOPO
EFF_TF	T
SHOWN_FIRM	T
SHR_ROUGH	MODERATE
L_RANGE	-9999
L_DIRECT	-9999
R_RANGE	-9999

old setup = 6.3'
wave HgT - Not 29.9'

Attachment 6A

FEMA Draft FIS 2013 - Cumberland

TABLE 11 – TRANSECT DATA - continued

TRANSECT	STILLWATER ELEVATIONS (FEET NAVD 88[3]) 10-PERCENT-ANNUAL-CHANCE	2-PERCENT-ANNUAL-CHANCE	1-PERCENT-ANNUAL-CHANCE	0.2-PERCENT-ANNUAL-CHANCE	TOTAL WATER LEVEL[1] 1-PERCENT-ANNUAL-CHANCE	ZONE	BASE FLOOD ELEVATION (FEET NAVD 88[2,3])
22	7.9	8.5	8.8	9.5	11.5	AE VE	19 19
23	7.9	8.5	8.8	9.5	14.3	VE	28
24	7.9	8.5	8.8	9.5	14.5	VE	22
25	7.9	8.5	8.8	9.5	14.1	VE	18
26	7.9	8.5	8.8	9.5	13.1	VE	20
27	7.9	8.5	8.8	9.5	12.1	VE	18
28	7.9	8.5	8.8	9.5	13.2	VE	19
29	7.9	8.5	8.8	9.5	13.2	VE	21
30	7.9	8.5	8.8	9.5	12.9	VE	21
31	7.9	8.5	8.8	9.5	14.6	VE	18
32	7.9	8.5	8.8	9.5	15	VE	40
33	7.9	8.5	8.8	9.5	14.2	VE	26
34	7.9	8.5	8.8	9.5	12.6	VE	20
35	8.0	8.6	8.9	9.5	11.6	VE	25

8.8 + 5.8 = 14.6

[1]Including stillwater elevation and effects of wave setup.
[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.
[3]North American Vertical Datum 1988

Attachment 7

2013_S_CST_TSCT_LN
CM-039

South Portland Old transect SP-2

Location: 895,035.487 91,601.324 Meters

Field	Value
TRAN_LN_ID	CM-039
TRAN_NO	039
CST_MDL_ID	20
SETUP_DPTH	1.2
SIG_HT	2.8
SIG_PD	11.1
CON_HT	7.3
CON_PD	-9999
MEAN_HT	-9999
MEAN_PD	11.1
SOURCE_CIT	STUDY1
EROS_METH	NOT APPLIED
TIME_UNIT	Seconds
V_DATUM	NAVD88
LEN_UNITS	Feet
VZONE_EXT	RUNUP
METHOD	FIELD SURVEY
EFF_TF	T
SHOWN_FIRM	T
SHR_ROUGH	MODERATE
L_RANGE	-9999
L_DIRECT	-9999
R_RANGE	-9999
R_DIRECT	-9999
LOC_DESC	The transect is located along the eastern shoreline of the City of South P
XCOORD	2934956

sea 7.0ft

Setup 1.2' old setup 2.8'

Attachment 8

1-2013_S_CST_TSCT_LN
CM-053

Portland Old Transect PL-11

Location: 897,714.536 90,334.265 Meters

Field	Value
TRAN_LN_ID	CM-053
TRAN_NO	053
CST_MDL_ID	31
SETUP_DPTH	2
SIG_HT	5.7
SIG_PD	12.5
CON_HT	14.9
CON_PD	-9999
MEAN_HT	-9999
MEAN_PD	12.5
SOURCE_CIT	STUDY1
EROS_METH	NOT APPLIED
TIME_UNIT	Seconds
V_DATUM	NAVD88
LEN_UNITS	Feet
VZONE_EXT	RUNUP
METHOD	CUT FROM TOPO
EFF_TF	T
SHOWN_FIRM	T
SHR_ROUGH	MODERATE
L_RANGE	-9999
L_DIRECT	-9999
R_RANGE	-9999
R_DIRECT	-9999
LOC_DESC	The transect is located at a point along the western shoreline of Spicers
XCOORD	2944333

old 26.5'

Setup 2.0' old setup 6.4'

Attachment 9

4-2013_S_CST_TSCT_LN
CM-127

Harpswell Old transect HW-35

Location: 2,987,738.201 330,624.749 Feet

Field	Value
TRAN_LN_ID	CM-127
TRAN_NO	127
CST_MDL_ID	34
SETUP_DPTH	1.5
SIG_HT	3.2
SIG_PD	12.5
CON_HT	8.3
CON_PD	-9999
MEAN_HT	-9999
MEAN_PD	12.5
SOURCE_CIT	STUDY1
EROS_METH	NOT APPLIED
TIME_UNIT	Seconds
V_DATUM	NAVD88
LEN_UNITS	Feet
VZONE_EXT	RUNUP
METHOD	CUT FROM TOPO
EFF_TF	T
SHOWN_FIRM	T
SHR_ROUGH	MODERATE
L_RANGE	-9999
L_DIRECT	-9999
R_RANGE	-9999
R_DIRECT	-9999
LOC_DESC	The transect is located at Ash Point, extending to the northeast toward
XCOORD	2988343

old 26.6'

Setup 1.5' old setup 6.1'

Attachment 10

2013_S_Cst_Tsct_Ln
23031C

Old Orchard Beach Old transect OB-6

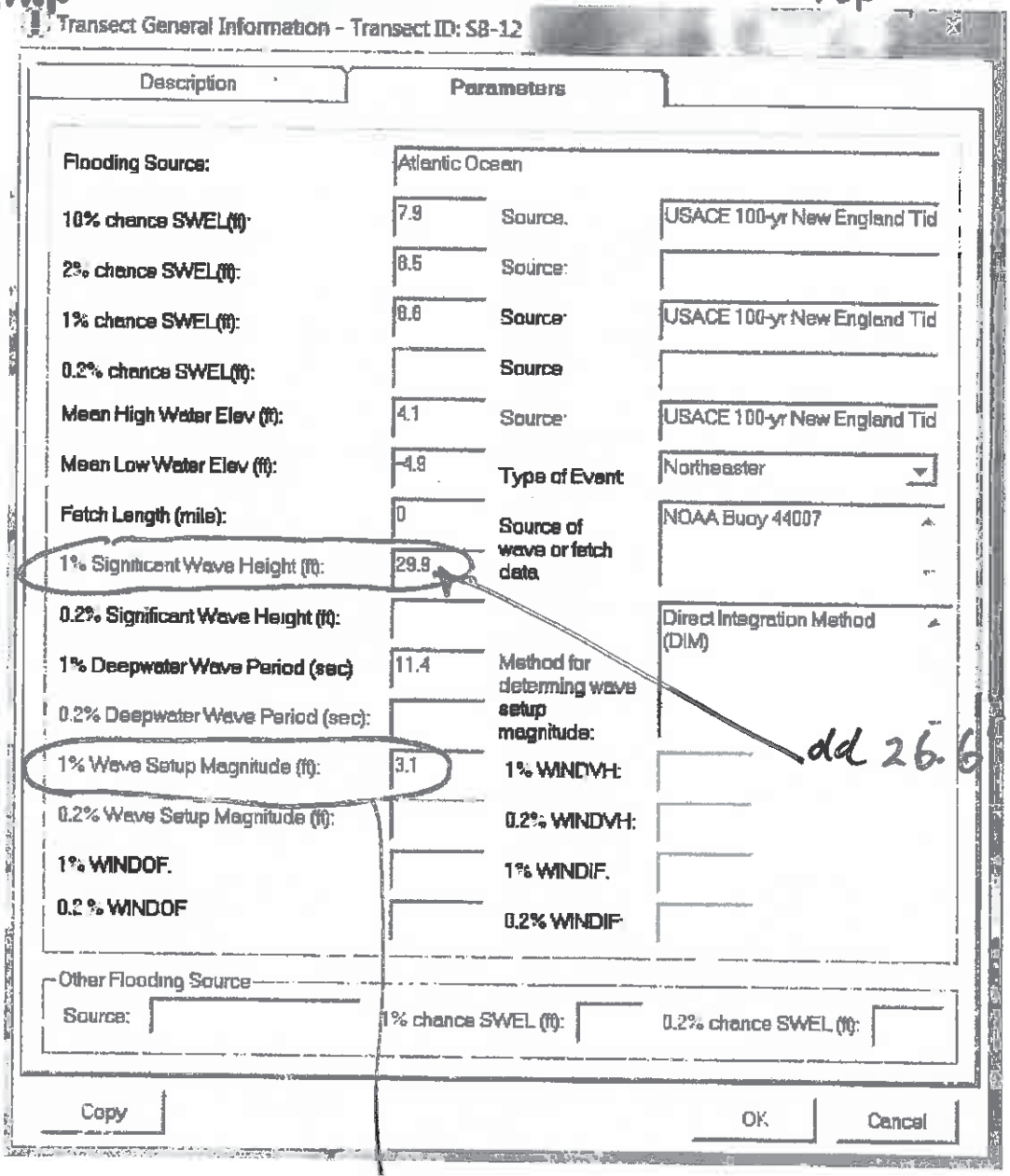
Location: 388,877.829 4,818,086.421 Meters

Field	Value
TRAN_LN_ID	YK-139
TBASELN_ID	139
TRAN_NO	139
METHOD	CUT FROM TOPO
XCOORD	2896866.12264
YCOORD	246235.110723
WTR_NM	Atlantic Ocean
V_DATUM	NAVD88
DATUM_CONV	0
CSTLN_TYP	Open Coast
BEACH_SET	SANDY BEACH BACKED BY LOW SAND BERM OR HIGH SAND DUNE FORM
CST_MDL_ID	9
EVENT_TYP	1 PERCENT CHANCE
SWEL	8.9
SIG_HT	42.65 old 22'
SIG_PD	11.4
CON_HT	0
CON_PD	0
MEAN_HT	0
MEAN_PD	0
FETCH_LEN	0
FTCHLNUNIT	FEET
EROS_METH	DUNE RETREAT
LOC_DESC	The transect crosses sandy beach and vegetated dunes, extends into de
LU_SOURCE	AERIAL
RUP	3

new set-up depth 4.1' old set-up depth 3.1'

Attachment 11
CM-004 Scarborough
FEMA CHAMP Model Input

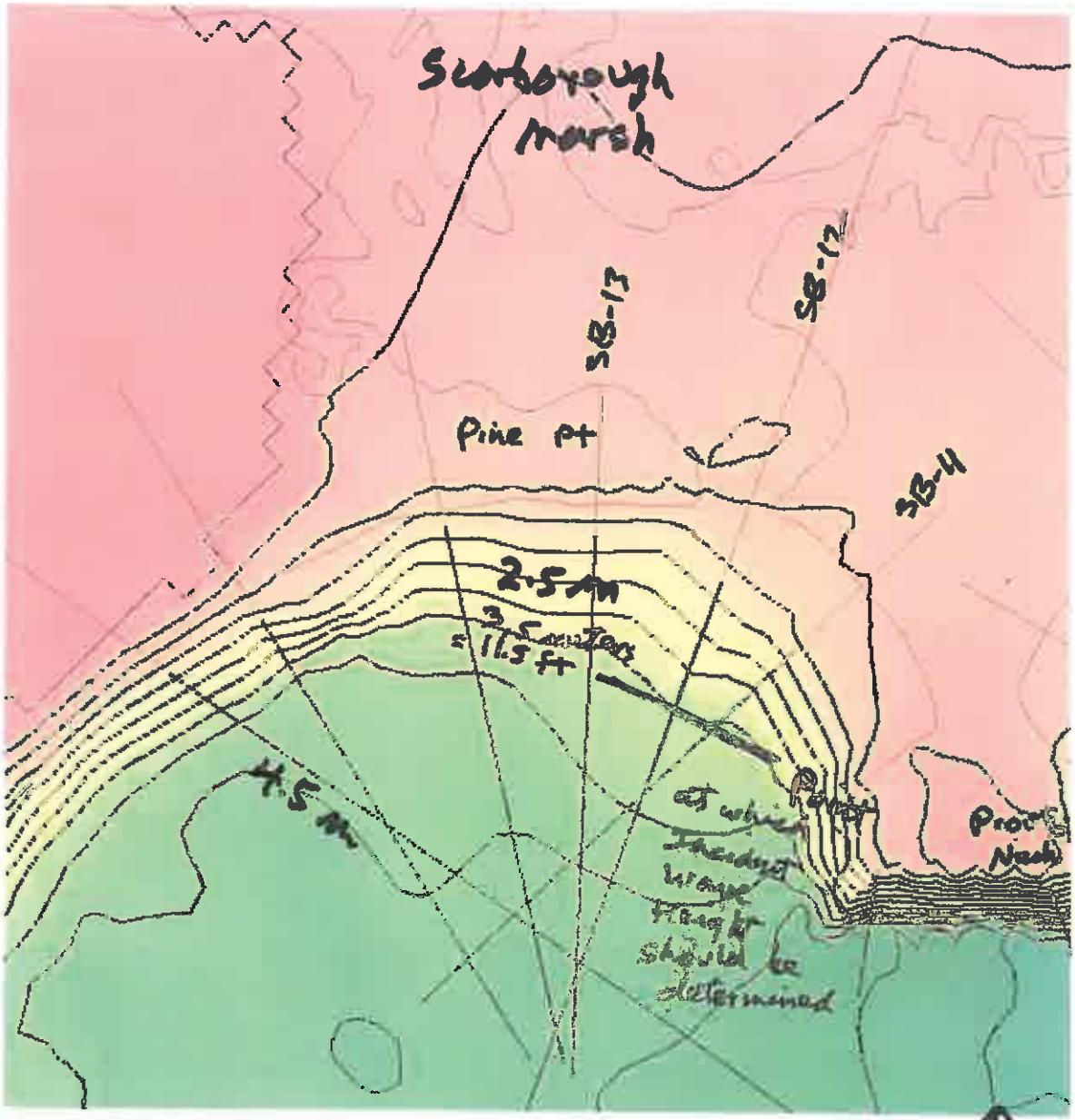
FEMA 2013 CHAMP



old 26.6

old wave setup 2.9'

Attachment 11



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FEMA STWAVE Model

Scarborough

Contours (0.5 m water interval) from FEMA STWAVE Model

Attachment 12

Created: 08/08/2007
Revised: 09/2012

Cumberland County, ME

OPEN COAST WAVE SETUP ANALYSIS FOR CUMBERLAND COUNTY, ME

Wave setup is an increase in the stillwater elevation against a barrier caused by the attenuation of waves in shallow water. Wave setup is based upon wave breaking characteristics and profile slope. Wave setup can be a significant contributer to the total water level at the shoreline and must be included in the determination of coastal base flood elevations. Wave setup is added to the storm stillwater elevation for WHAFIS calculations, but not added to the stillwater elevation for wave runup calculations. The following methodology (Direct Integration Method [DIM]) should be used for calculating wave setup for each coastal transect to be modeled in CHAMP.

old # Version #

Transect: SB-12 CM-004

STEP 1: PROVIDE WAVE PARAMETERS AND AVERAGE NEARSHORE SLOPE FOR TRANSECT

$Ho := 29.9ft$ Deepwater significant wave height (determined by STWAVE Model)

$T_m := 11.4sec$ Peak wave period (determined by STWAVE Model)

$m := \frac{1}{184}$ Average slope of transect (determined using GIS)

STEP 2: DETERMINE DEEP WATER WAVE LENGTH (L_o)

$Lo := \frac{g \cdot T^2}{2.\pi}$ Deep water wave length $Lo = 665.5\,ft$

$\frac{Ho}{Lo} = 0.045$ Wave Steepness

STEP 3: CALCULATE SETUP USING DIM METHOD

$\eta := Ho \cdot 0.16 \cdot \frac{m^{0.2}}{\left(\frac{Ho}{Lo}\right)^{0.2}}$ Equation D.2.6-1

$\eta = 3.1\,ft$ Wave Setup

REFERENCE: Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update, FEMA, February 2007.
Random Seas And Design of Marine Structures, Y. Goda

Attachment 13

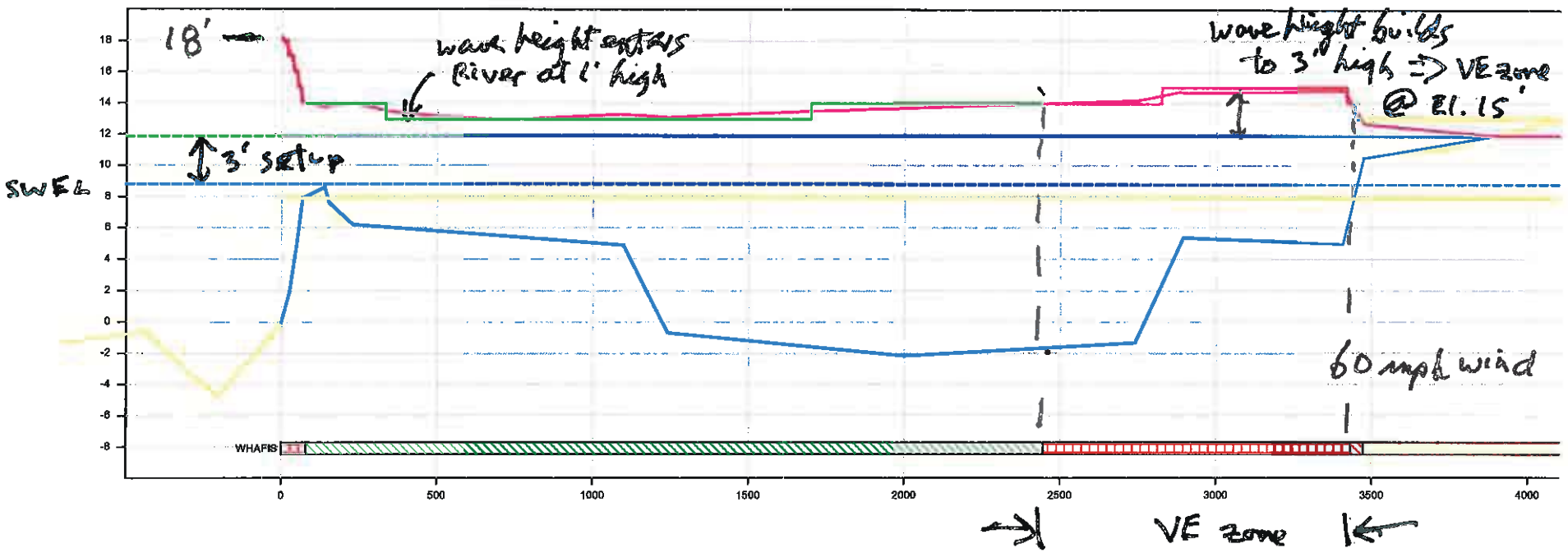
FEMA CHAMP - WHAFIS - OUTPUT

PART6 NUMBERED A ZONES AND V ZONES

STATION OF GUTTER	ELEVATION	ZONE DESIGNATION	FHF
0.00	18.22		
		V12 EL=18	60
18.67	17.50		
		V12 EL=17	60
36.16	16.50		
		V12 EL=16	60
50.26	15.50		
		V12 EL=15	60
61.91	14.50		
		V12 EL=14	60
78.86	14.00		
		A11 EL=14	55
332.63	13.50		
		A11 EL=13	55
1697.28	13.50		
		A11 EL=14	55
2446.12	14.00		
		V12 EL=14	60
2822.31	14.50		
		V12 EL=15	60
3416.97	14.50		
		V12 EL=14	60
3432.21	14.00		
		A 8 EL=14	40
3447.45	13.50		
		A 8 EL=13	40
3473.00	12.66		

Attachment 14

FEMA CHAMP Model Graphic Profile Output



Attachment 15

Created: 08/09/2007
Revised: 09/2012

11/19/13

Cumberland County, ME

RGG

OPEN COAST WAVE SETUP ANALYSIS FOR CUMBERLAND COUNTY, ME

Wave setup is an increase in the stillwater elevation against a barrier caused by the attenuation of waves in shallow water. Wave setup is based upon wave breaking characteristics and profile slope. Wave setup can be a significant contributer to the total water level at the shoreline and must be included in the determination of coastal base flood elevations. Wave setup is added to the storm stillwater elevation for WHAFIS calculations, but not added to the stillwater elevation for wave runup calculations. The following methodology (Direct Integration Method [DIM]) should be used for calculating wave setup for each coastal transect to be modeled in CHAMP.

based on FEMA's own STWAVE Model

Transect: SB-12

STEP 1: PROVIDE WAVE PARAMETERS AND AVERAGE NEARSHORE SLOPE FOR TRANSECT

$Ho := 11.5ft$ Deepwater significant wave height (determined by STWAVE Model)

$T := 11.4sec$ Peak wave period (determined by STWAVE Model)

$m := \frac{1}{184}$ Average slope of transect (determined using GIS)

STEP 2: DETERMINE DEEP WATER WAVE LENGTH (L_o)

$Lo := \frac{g \cdot T^2}{2\pi}$ Deep water wave length $Lo = 665.5\,ft$

$\frac{Ho}{Lo} = 0.017$ Wave Steepness

STEP 3: CALCULATE SETUP USING DIM METHOD

$\eta := Ho \cdot 0.16 - \frac{m^{0.2}}{\left(\frac{Ho}{Lo}\right)^{0.2}}$ Equation D.2.6-1

$\eta = 1.5ft$ Wave Setup

REFERENCE: Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update, FEMA, February 2007.
Random Seas And Design of Marine Structures, Y. Goda

Attachment 16

RGG CHAMP Model Graphics Output