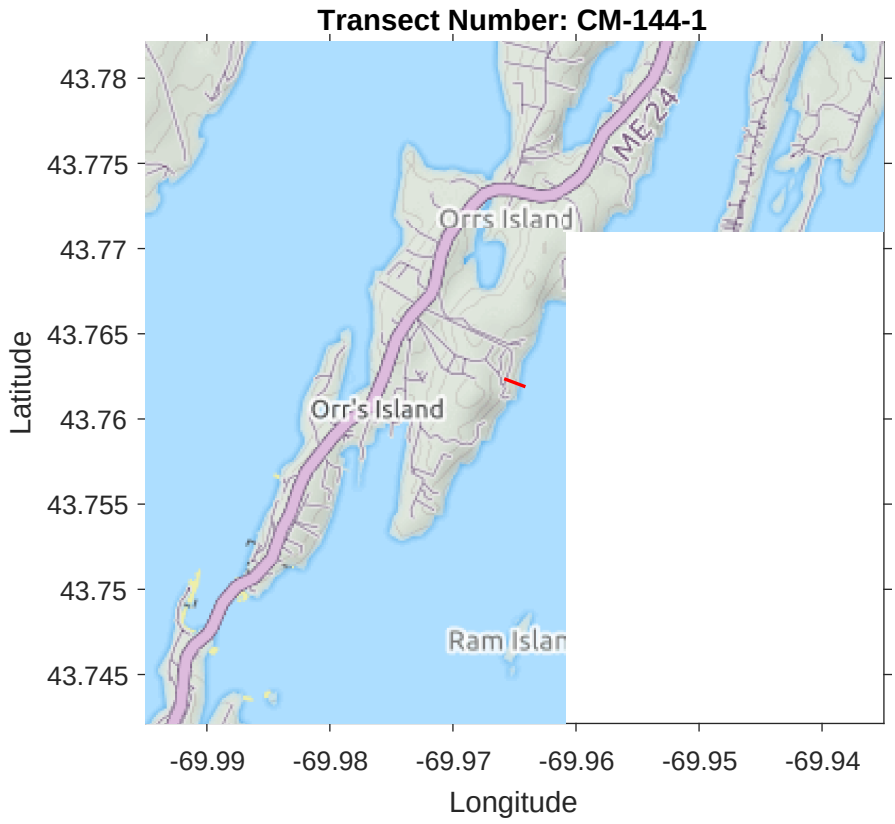
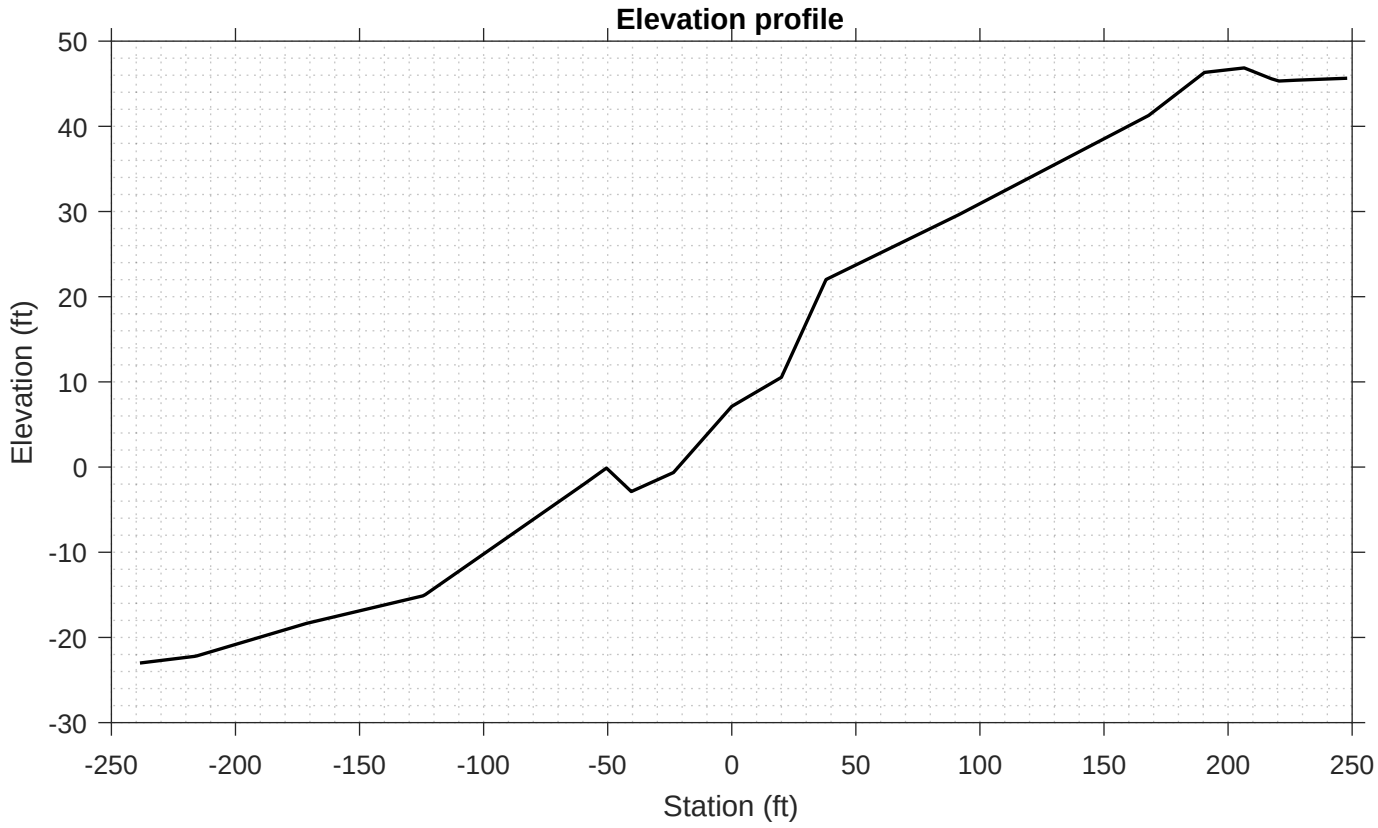

Transect Number: CM-144-1
43.78
43.775
43.77
43.765
43.76
43.755
43.75
43.745
Latitude
ME 24
Orrs Island
Orr's Island
Ram Islan
-69.99
-69.98
-69.97
-69.96
-69.95
-69.94
Longitude


Elevation profile
50
40
30
20
10
0
-10
-20
-30
Elevation (ft)
-250
-200
-150
-100
-50
0
50
100
150
200
250
Station (ft)

DATA LOG FOR TRANSECT ID: CM-144-1

PART 1: USER INPUT

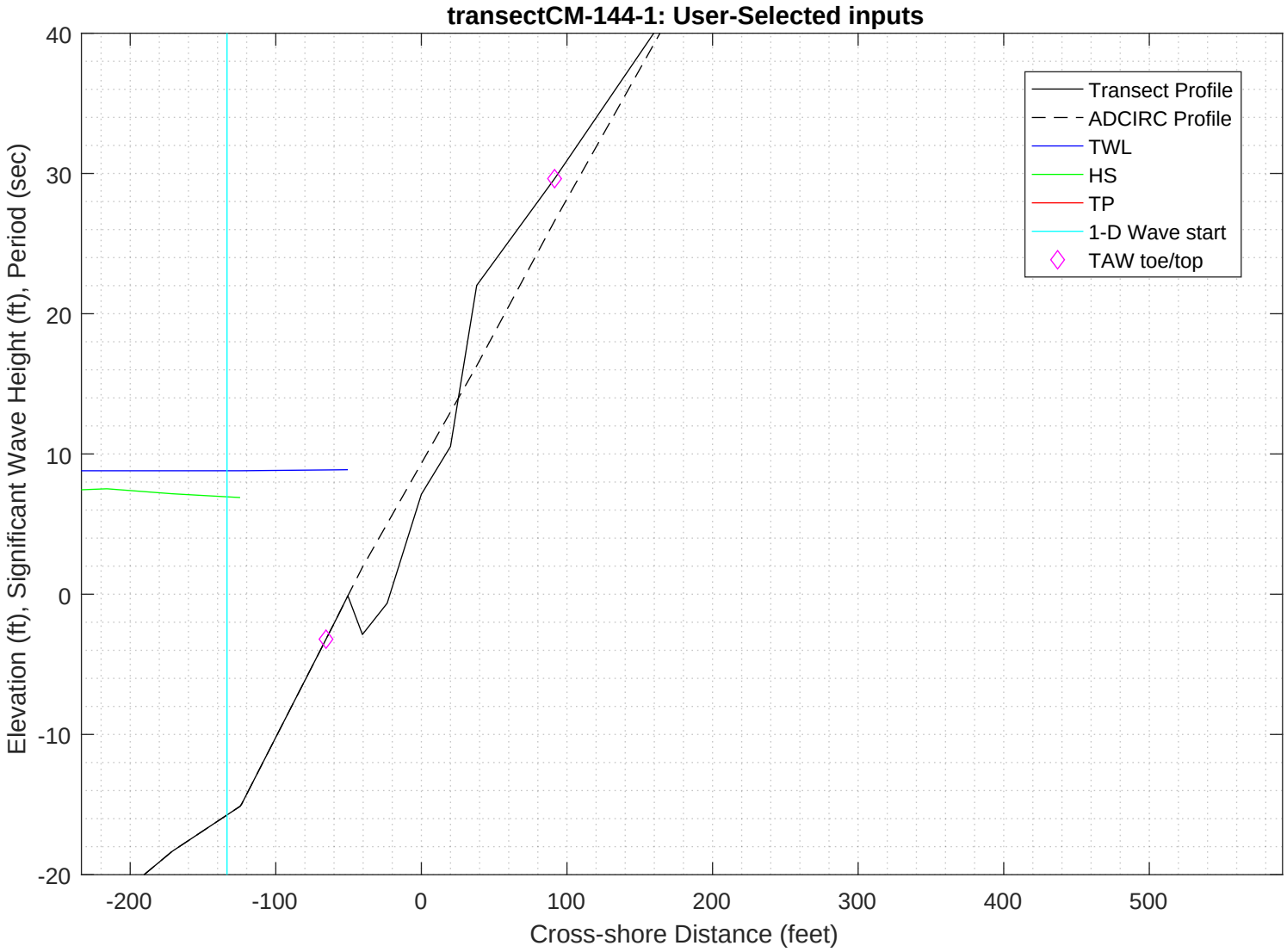
SWAN 1-D / WHAFIS input

station: -133.5 ft
LON: -69.9645 deg E
LAT: 43.762 deg N
Bottom ELEV: -15.7402 ft-NAVD88
TWL: 8.8043 ft-NAVD88
HS: 6.9445 ft
TP: NaN sec
Wave Direction bin: 180 deg CCW from East (90 deg sector)
Transect Direction: 164.7455 deg CCW from East

TAW/RUNUP input

toe sta: -65.5 ft
toe elev: -3.2072 ft-NAVD88
top sta: 91.5 ft
top elev: 29.6293 ft-NAVD88
Wave and water level conditions at toe to be calculated in SWAN 1-D

PART 1 COMPLETE


transectCM-144-1: User-Selected inputs
Transect Profile
ADCIRC Profile
TWL
HS
TP
1-D Wave start
TAW toe/top
Elevation (ft), Significant Wave Height (ft), Period (sec)
Cross-shore Distance (feet)
40
30
20
10
0
-10
-20
-200
-100
0
100
200
300
400
500

_____
PART 2: SWAN 1-D

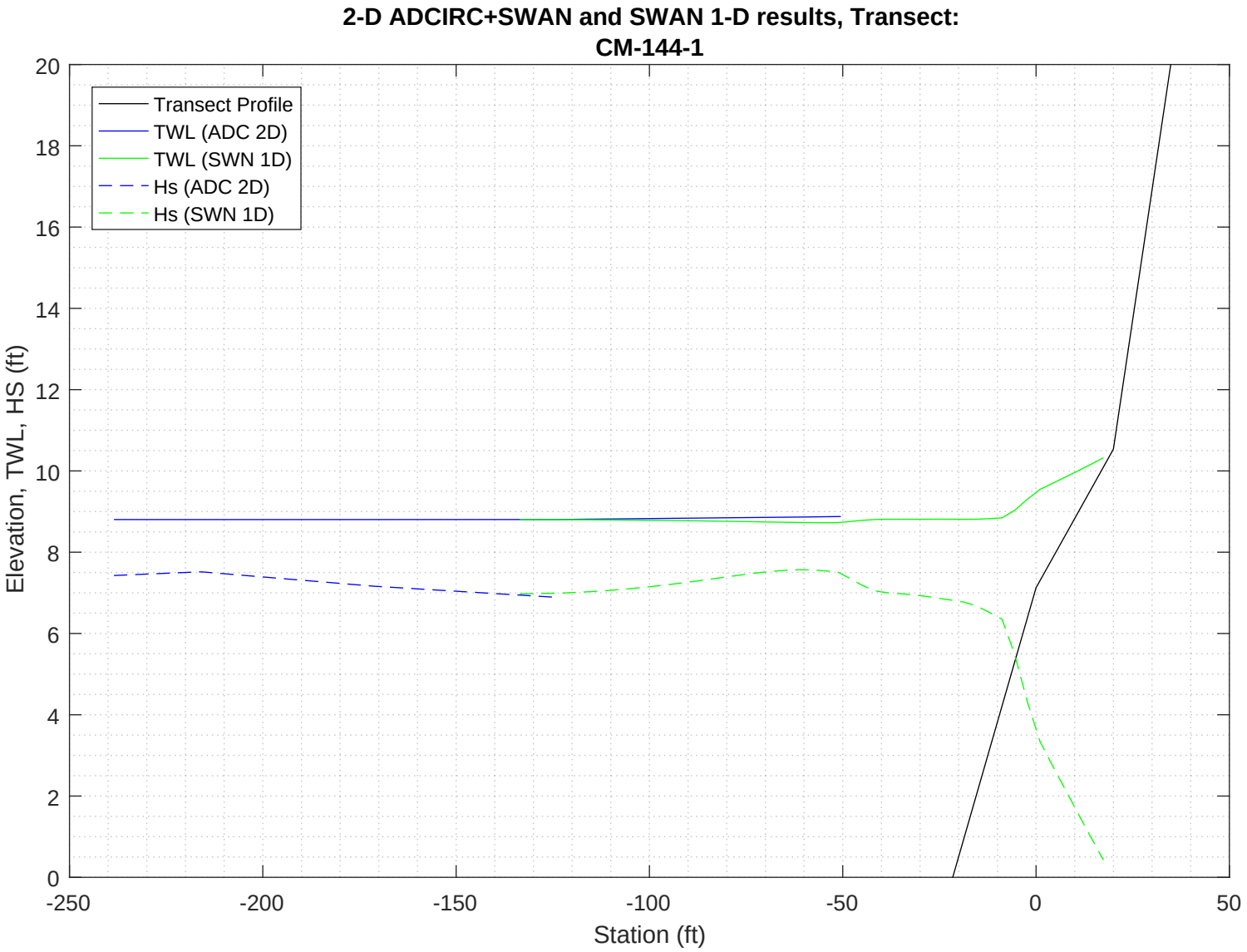
swan input grid name: 2_swan/gridfiles/CM-144-1zmeters_xmeters.grd
swan file name: 2_swan/swanfiles/CM-144-1.swn
swan output name: 2_swan/swanfiles/CM-144-1.dat

Boundary Conditions:
    TWL- 2.6836 meters
    HS- 2.1167 meters
    PER- 10 seconds

Batch File: 2_swan/swanfiles/runswan.dat

SWAN maximum additional wave setup: 1.5194 feet
SWAN output at toe:
    SETUP- -0.068077 feet
    HS-   7.5548 feet
    PER-   9.9345 seconds

PART 2 COMPLETE_____


2-D ADCIRC+SWAN and SWAN 1-D results, Transect:
CM-144-1
Transect Profile
TWL (ADC 2D)
TWL (SWN 1D)
Hs (ADC 2D)
Hs (SWN 1D)
Elevation, TWL, HS (ft)
Station (ft)
20
18
16
14
12
10
8
6
4
2
0
-250
-200
-150
-100
-50
0
50

1

```
                    Execution started at 20200226.095825


                    ---------------------------------------
                                    SWAN
                    SIMULATION OF WAVES IN NEAR SHORE AREAS
                             VERSION NUMBER 41.20A
                    ---------------------------------------


 PROJECT '2018FemaAppeal' '1'
    '100-year Wind and Wave conditions'
 ! -- SET commands ------------------------------------------------------
  SET DEPMIN=0.01 MAXMES=999 MAXERR=3 PWTAIL=4
  SET LEVEL 0
  SET CARTESIAN
 ! -- MODE commands -----------------------------------------------------
  MODE STATIONARY ONED
 !-- COORDINATES commands-----------------------------------------------
 COORDINATES CART
 !
 !  --  computational (CGRID) grid commands -------------------------------------
 !                                   xlenc=length of grid in meters
 !  mxc = number of mesh cells (one less than number of grid points)
 !CGRID REGular [xpc]  [ypc]  [alpc]  [xlenc]   [ylenc]  [mxc]  [myc] &
 !      [ CIRcle|SECtor[dir1] [dir2] ] [mdc] [flow] [fhigh] [msc]
  CGRID REGULAR   0      0       0      46       0.   46     0    &
        CIRCLE                          36    0.03    0.8     30
 Resolution in sigma-space: df/f =  0.1157
 ! -- READgrid ---- not used in 1-D mode ----------------------------------
 ! -- INPgrid commands  -------------------------------------------------------
 !INPgrid BOTtom REGular [xpinp] [ypinp] [alpinp] [mxinp] [myinp] [dxinp] [dyinp]
 !
  INPGRID BOTTOM REGULAR    0       0        0      46   0      1       1
 !READinp BOTtom [fac]  'fname1'  [idla]  [nhedf]  [FREe|FORmat[form]|UNFormatted]
  READ    BOTTOM   -1. '../gridfiles/CM-144-1zmeters_xmeters.grd'    1      0       FREE
 !-------------------------------------------------------------------------
 ! -- WIND [vel] [dir]
 WIND      25.1  0
 ! -- BOUnd SHAPespec
 BOUND SHAPE JONSWAP 3.3  PEAK DSPR POWER
 ! -- BOUndspec
 ! BOU SIDE W CCW CON FILE 'swanspec.txt' 1
 BOUN SIDE W CCW CONSTANT PAR   2.1167     10     0  2
 !-- BOUndnest1  - optional for boundary from parent run
 !-- BOUndnest2
 !-- BOUndnest3
 !-- INITial -- usest to specify initial values
 !
```

```
!---------------- P H Y S I C S ------------------------
!-- GEN1 [cf10] [cf20] [cf30] [cf40] [edm1pm] [cdrag] [umin] [cfpm]
!-- GEN2 [cf10] [cf20] [cf30] [cf40] [cf50] [cf60] [edm1pm] [cdrag] [umin] [cfpm]
    GEN3 KOMEN
!   whitecapping ( on by default)
!-- WCAPping KOMen [cds2] [stpm] [powst] [delta] [powk]
    WCAP KOM
!   quadruplet wave interactions
!-- QUADrupl [iquad] [lambda] [Cn14] [Csh1] [Csh2]
! -- BREaking CONstant [alpha] [gamma]
     BREAK    CON       1.      0.73
!-- FRICtion JONswap CONstant [cfjon]
    FRIC     JONSWAP CON       0.038
!-- TRIad [itriad] [trfac] [cutfr]   [a]  [b]  [urcrit] [urslim]
! TRIAD        1      0.65    2.5    0.95 -0.75  0.2       0.01
  TRIAD
!-- VEGEtation [height] [diamtr] [nstems] [drag]
!-- MUD [layer] [rhom] [viscm]
!- LIMiter [ursell] [qb] deactivates quadruplets with Ursell number exceeds ursell
!-- OBSTacle -- not in 1-D
!-- SETUP [supcor]
   SETUP    0
!
! ----------------- N U M E R I C S -----------------------------
!
!-- PROP  can use BBST or GSE instead of default
! -- NUMeric -- lots of options
!     NUM ACCUR npnts=100. stat 30
     NUMeric STOPC
!
! -------------------O U T P U T ------------------------------
!
!OUTPut OPTIons "comment' (TABLE [field]) (BLOck [ndec] [len]) (SPEC [ndec])
 OUTPUT OPTIONS '%' TABLE 16
 $BLOCK 9 1000 SPEC 8
!CURve 'sname' [xp1] [yp1] <[int]   [xp]   [yp] >
 CURVE 'curve' 0     0      46  46    0
!TABLe 'sname' < HEADer|NOHEADer|INDexed > 'fname' <output parameters> (output time)
 Table 'curve'   HEADER 'CM-144-1.dat' XP YP HSIGN TPS RTP TMM10 DIR &
 DSPR DEPTH SETUP
!QUANTITY XP hexp=99999
!
!-----------------------------------------------
COMPUTE STATIONARY
------------------------------------------------------------------
                 COMPUTATIONAL PART OF SWAN
------------------------------------------------------------------
```

```
One-dimensional mode of SWAN is activated
Gridresolution       : MXC              47 MYC              1
                     : MCGRD            48
                     : MSC              31 MDC             36
                     : MTC               1
                     : NSTATC            0 ITERMX          50
Propagation flags    : ITFRE             1 IREFR            1
Source term flags    : IBOT              1 ISURF            1
                     : IWCAP             1 IWIND            3
                     : ITRIAD            1 IQUAD            2
                     : IVEG              0 ITURBV           0
                     : IMUD              0
Spatial step         : DX       0.1000E+01 DY      0.1000E+01
Spectral bin         : df/f     0.1157E+00 DDIR    0.1000E+02
Physical constants   : GRAV     0.9810E+01 RHO     0.1025E+04
Wind input           : WSPEED   0.2510E+02 DIR     0.0000E+00
Tail parameters      : E(f)     0.4000E+01 E(k)    0.2500E+01
                     : A(f)     0.5000E+01 A(k)    0.3000E+01
Accuracy parameters  : DREL     0.1000E-01 NPNTS   0.9950E+02
                     : DHABS    0.0000E+00 CURVAT  0.5000E-02
                     : GRWMX    0.1000E+00
Drying/flooding      : LEVEL    0.0000E+00 DEPMIN  0.1000E-01
The Cartesian convention for wind and wave directions is used
Scheme for geographic propagation is SORDUP
Scheme geogr. space  : PROPSC            2 ICMAX            7
Scheme spectral space: CSS      0.5000E+00 CDD     0.5000E+00
Current is off
Quadruplets          : IQUAD             2
                     : LAMBDA   0.2500E+00 CNL4    0.3000E+08
                     : CSH1     0.5500E+01 CSH2    0.8330E+00
                     : CSH3    -0.1250E+01
Maximum Ursell nr for Snl4 :    0.1000E+02
Triads               : ITRIAD            1 TRFAC   0.8000E+00
                     : CUTFR    0.2500E+01 URCRI   0.2000E+00
Minimum Ursell nr for Snl3 :    0.1000E-01
JONSWAP (‘73)        : GAMMA    0.3800E-01
Vegetation is off
Turbulence is off
Fluid mud is off
W-cap Komen (‘84)    : EMPCOF (CDS2):   0.2360E-04
W-cap Komen (‘84)    : APM (STPM)   :   0.3020E-02
W-cap Komen (‘84)    : POWST        :   0.2000E+01
W-cap Komen (‘84)    : DELTA        :   0.1000E+01
W-cap Komen (‘84)    : POWK         :   0.1000E+01
Wind drag is fit
Snyder/Komen wind input
Battjes&Janssen (‘78): ALPHA    0.1000E+01 GAMMA   0.7300E+00
Set-up               : SUPCOR   0.0000E+00
Diffraction is off
Janssen (‘89,‘90)    : ALPHA    0.1000E-01 KAPPA   0.4100E+00
Janssen (‘89,‘90)    : RHOA     0.1280E+01 RHOW    0.1025E+04

1st and 2nd gen. wind: CF10     0.1880E+03 CF20    0.5900E+00
                     : CF30     0.1200E+00 CF40    0.2500E+03
                     : CF50     0.2300E-02 CF60   -0.2230E+00
                     : CF70     0.0000E+00 CF80   -0.5600E+00
                     : RHOAW    0.1249E-02 EDMLPM  0.3600E-02
                     : CDRAG    0.1230E-02 UMIN    0.1000E+01
                     : LIM_PM   0.1300E+00

 ---------------------------------------------------------------
 First guess by 2nd generation model flags for first iteration:
 ITER       1 GRWMX      0.1000E+23 ALFA       0.0000E+00
 IWIND      2 IWCAP      0 IQUAD      0
 ITRIAD     1 IBOT       1 ISURF      1
 IVEG       0 ITURBV     0 IMUD       0
 ---------------------------------------------------------------
iteration    1; sweep 1
iteration    1; sweep 2
iteration    1; sweep 3
iteration    1; sweep 4
not possible to compute, first iteration

 ---------------------------------------------------------------
 Options given by user are activated for proceeding calculation:
 ITER       2 GRWMX      0.1000E+00 ALFA       0.0000E+00
 IWIND      3 IWCAP      1 IQUAD      2
 ITRIAD     1 IBOT       1 ISURF      1
 IVEG       0 ITURBV     0 IMUD       0
 ---------------------------------------------------------------
iteration    2; sweep 1
iteration    2; sweep 2
iteration    2; sweep 3
iteration    2; sweep 4
accuracy OK in  36.18 % of wet grid points ( 99.50 % required)

iteration    3; sweep 1
iteration    3; sweep 2
iteration    3; sweep 3
```

```
iteration    3; sweep 4
accuracy OK in   2.13 % of wet grid points ( 99.50 % required)

iteration    4; sweep 1
iteration    4; sweep 2
iteration    4; sweep 3
iteration    4; sweep 4
accuracy OK in  31.92 % of wet grid points ( 99.50 % required)

iteration    5; sweep 1
iteration    5; sweep 2
iteration    5; sweep 3
iteration    5; sweep 4
accuracy OK in  65.96 % of wet grid points ( 99.50 % required)

iteration    6; sweep 1
iteration    6; sweep 2
iteration    6; sweep 3
iteration    6; sweep 4
accuracy OK in  91.49 % of wet grid points ( 99.50 % required)

iteration    7; sweep 1
iteration    7; sweep 2
iteration    7; sweep 3
iteration    7; sweep 4
accuracy OK in  91.49 % of wet grid points ( 99.50 % required)

iteration    8; sweep 1
iteration    8; sweep 2
iteration    8; sweep 3
iteration    8; sweep 4
accuracy OK in  93.62 % of wet grid points ( 99.50 % required)

iteration    9; sweep 1
iteration    9; sweep 2
iteration    9; sweep 3
iteration    9; sweep 4
accuracy OK in  93.62 % of wet grid points ( 99.50 % required)

iteration   10; sweep 1
iteration   10; sweep 2
iteration   10; sweep 3
iteration   10; sweep 4
accuracy OK in  93.62 % of wet grid points ( 99.50 % required)

iteration   11; sweep 1
iteration   11; sweep 2
iteration   11; sweep 3
iteration   11; sweep 4
accuracy OK in  93.62 % of wet grid points ( 99.50 % required)

iteration   12; sweep 1
iteration   12; sweep 2
iteration   12; sweep 3
iteration   12; sweep 4
accuracy OK in  93.62 % of wet grid points ( 99.50 % required)

iteration   13; sweep 1
iteration   13; sweep 2
iteration   13; sweep 3
iteration   13; sweep 4
accuracy OK in  93.62 % of wet grid points ( 99.50 % required)

iteration   14; sweep 1
iteration   14; sweep 2
iteration   14; sweep 3
iteration   14; sweep 4
accuracy OK in  95.75 % of wet grid points ( 99.50 % required)

iteration   15; sweep 1
iteration   15; sweep 2
iteration   15; sweep 3
iteration   15; sweep 4
accuracy OK in  95.75 % of wet grid points ( 99.50 % required)

iteration   16; sweep 1
iteration   16; sweep 2
iteration   16; sweep 3
iteration   16; sweep 4
accuracy OK in  95.75 % of wet grid points ( 99.50 % required)

iteration   17; sweep 1
iteration   17; sweep 2
iteration   17; sweep 3
iteration   17; sweep 4
accuracy OK in  97.88 % of wet grid points ( 99.50 % required)

iteration   18; sweep 1
iteration   18; sweep 2
iteration   18; sweep 3
```

```
iteration   18; sweep 4
accuracy OK in  97.88 % of wet grid points ( 99.50 % required)

iteration   19; sweep 1
iteration   19; sweep 2
iteration   19; sweep 3
iteration   19; sweep 4
accuracy OK in  97.88 % of wet grid points ( 99.50 % required)

iteration   20; sweep 1
iteration   20; sweep 2
iteration   20; sweep 3
iteration   20; sweep 4
accuracy OK in  97.88 % of wet grid points ( 99.50 % required)

iteration   21; sweep 1
iteration   21; sweep 2
iteration   21; sweep 3
iteration   21; sweep 4
accuracy OK in  97.88 % of wet grid points ( 99.50 % required)

iteration   22; sweep 1
iteration   22; sweep 2
iteration   22; sweep 3
iteration   22; sweep 4
accuracy OK in  97.88 % of wet grid points ( 99.50 % required)

iteration   23; sweep 1
iteration   23; sweep 2
iteration   23; sweep 3
iteration   23; sweep 4
accuracy OK in  97.88 % of wet grid points ( 99.50 % required)

iteration   24; sweep 1
iteration   24; sweep 2
iteration   24; sweep 3
iteration   24; sweep 4
accuracy OK in  97.88 % of wet grid points ( 99.50 % required)

iteration   25; sweep 1
iteration   25; sweep 2
iteration   25; sweep 3
iteration   25; sweep 4
accuracy OK in  97.88 % of wet grid points ( 99.50 % required)

iteration   26; sweep 1
iteration   26; sweep 2
iteration   26; sweep 3
iteration   26; sweep 4
accuracy OK in  97.88 % of wet grid points ( 99.50 % required)

iteration   27; sweep 1
iteration   27; sweep 2
iteration   27; sweep 3
iteration   27; sweep 4
accuracy OK in 100.00 % of wet grid points ( 99.50 % required)


STOP
```

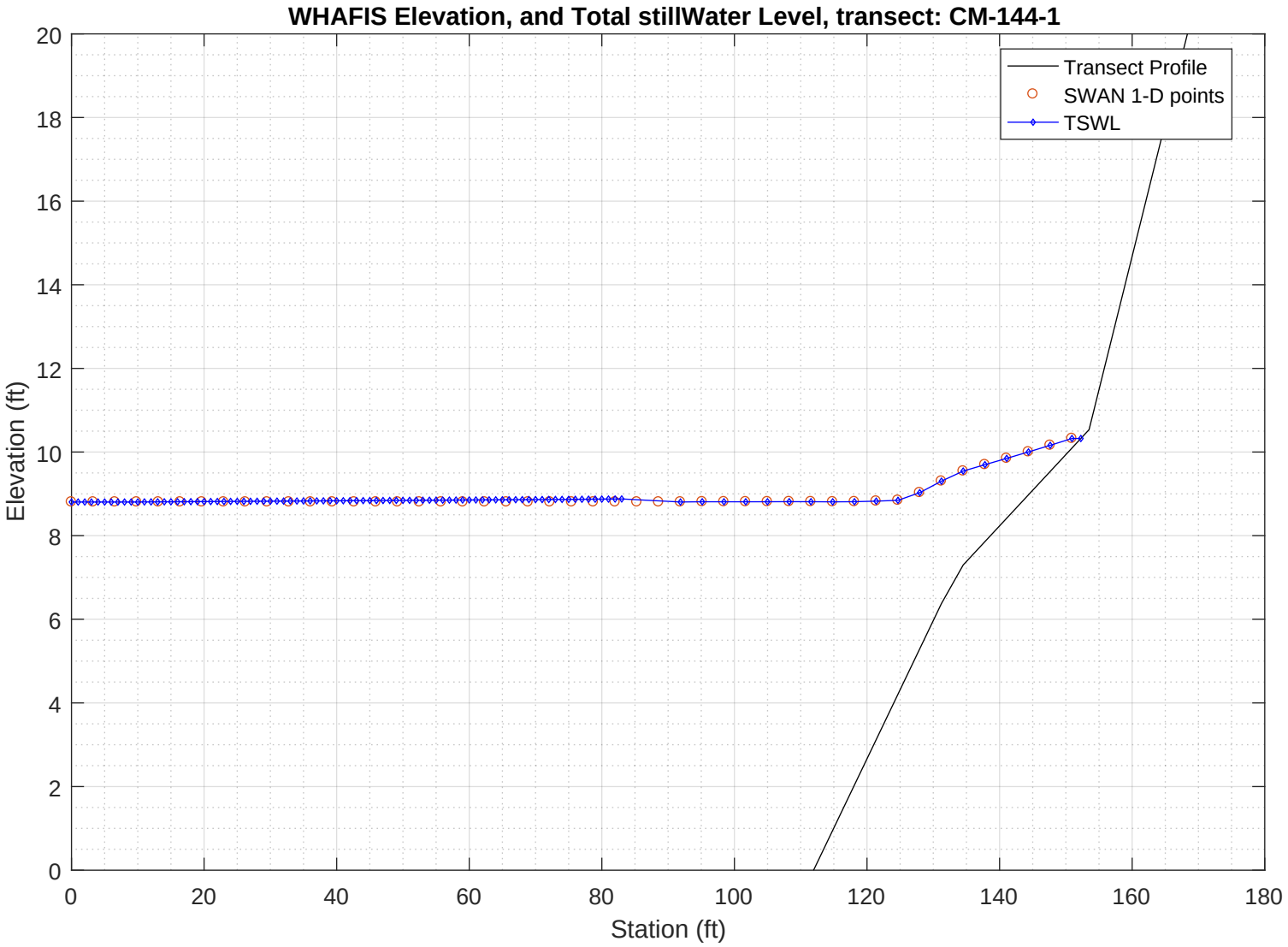
%
%
% Run:1 Table:curve SWAN version:41.20A
%
% Xp Yp Hsig TPsmoo RTpeak Tm_10 Dir Dspr Depth Setup
% [m] [m] [m] [sec] [sec] [sec] [degr] [degr] [m] [m]
%

Xp [m]	Yp [m]	Hsig [m]	TPsmoo [sec]	RTpeak [sec]	Tm_10 [sec]	Dir [degr]	Dspr [degr]	Depth [m]	Setup [m]
0.	0.	2.12617	9.9090	10.0005	9.0377	0.000	31.5072	7.4800	0.000000
1.	0.	2.12813	9.9093	10.0005	9.0128	0.000	31.2529	7.4098	-0.000165
2.	0.	2.12994	9.9096	10.0005	8.9879	0.000	30.9950	7.3397	-0.000330
3.	0.	2.13095	9.9100	10.0005	8.9630	0.000	30.6554	7.2495	-0.000531
4.	0.	2.13512	9.9106	10.0005	8.9400	0.000	30.1712	7.0490	-0.001050
5.	0.	2.13965	9.9113	10.0005	8.9145	0.000	29.6377	6.8484	-0.001619
6.	0.	2.14505	9.9121	10.0005	8.8861	0.000	29.0887	6.6478	-0.002247
7.	0.	2.15140	9.9129	10.0005	8.8547	0.000	28.5277	6.4471	-0.002940
8.	0.	2.15933	9.9138	10.0005	8.8200	0.000	28.0253	6.2363	-0.003719
9.	0.	2.16780	9.9147	10.0005	8.7809	0.000	27.5408	6.0355	-0.004525
10.	0.	2.17707	9.9158	10.0005	8.7379	0.000	27.0412	5.8346	-0.005409
11.	0.	2.18777	9.9170	10.0005	8.6911	0.000	26.5314	5.6236	-0.006426
12.	0.	2.19877	9.9183	10.0005	8.6398	0.000	26.0163	5.4225	-0.007488
13.	0.	2.21055	9.9196	10.0005	8.5846	0.000	25.4958	5.2214	-0.008647
14.	0.	2.22288	9.9211	10.0005	8.5255	0.000	24.9568	5.0201	-0.009909
15.	0.	2.23636	9.9227	10.0005	8.4630	0.000	24.4401	4.8087	-0.011327
16.	0.	2.24952	9.9245	10.0005	8.3953	0.000	23.9379	4.6072	-0.012765
17.	0.	2.26246	9.9263	10.0005	8.3242	0.000	23.4179	4.4057	-0.014290
18.	0.	2.27561	9.9282	10.0005	8.2508	0.000	22.8847	4.1940	-0.015981
19.	0.	2.28677	9.9303	10.0005	8.1747	0.000	22.3449	3.9924	-0.017608
20.	0.	2.29610	9.9324	10.0005	8.0976	0.000	21.7891	3.7908	-0.019222
21.	0.	2.30272	9.9345	10.0005	8.0204	0.000	21.2061	3.5892	-0.020750
22.	0.	2.30679	9.9366	10.0005	7.9444	0.000	20.6038	3.3778	-0.022242
23.	0.	2.30518	9.9387	10.0005	7.8696	0.000	20.0216	3.1768	-0.023218
24.	0.	2.29896	9.9407	10.0005	7.7982	0.000	19.4190	2.9661	-0.023877
25.	0.	2.29213	9.9422	10.0005	7.6928	0.000	19.1254	2.7563	-0.023670
26.	0.	2.24280	9.9424	10.0005	7.5751	0.000	19.6235	2.8948	-0.015242
27.	0.	2.18902	9.9418	10.0005	7.4758	359.989	20.6126	3.1839	-0.006117
28.	0.	2.14857	9.9410	10.0005	7.3998	359.979	21.3026	3.4602	0.000177
29.	0.	2.13305	9.9404	10.0005	7.3640	359.976	21.3295	3.4719	0.001919
30.	0.	2.12727	9.9400	10.0005	7.3476	359.976	21.0335	3.3418	0.001771
31.	0.	2.11895	9.9394	10.0005	7.3306	359.977	20.6218	3.2118	0.001762
32.	0.	2.10743	9.9388	10.0005	7.3148	359.975	20.1937	3.0820	0.002025
33.	0.	2.09265	9.9380	10.0005	7.2956	359.975	19.6410	2.9526	0.002561
34.	0.	2.07956	9.9374	10.0005	7.2805	359.969	18.8557	2.7223	0.002263
35.	0.	2.06421	9.9374	10.0005	7.2732	359.972	17.8524	2.3913	0.001295
36.	0.	2.03539	9.9379	10.0005	7.2319	359.981	16.7374	2.0623	0.002297
37.	0.	1.98721	9.9401	10.0005	7.1918	359.950	15.5739	1.7364	0.006430
38.	0.	1.93662	9.9453	10.0005	7.0884	359.826	14.3684	1.4124	0.012366
39.	0.	1.67272	9.9570	10.0005	7.3549	359.619	14.0287	1.1383	0.068299
40.	0.	1.31806	10.0035	10.0005	7.7573	358.789	13.7567	0.8921	0.152127
41.	0.	1.01903	10.1191	10.0005	8.1700	358.577	13.4087	0.6857	0.225678
42.	0.	0.83546	12.3066	12.4477	8.1212	358.259	12.8304	0.5623	0.272257
43.	0.	0.65718	12.4552	12.4477	8.3463	357.916	13.0263	0.4382	0.318240
44.	0.	0.47963	12.7143	12.4477	8.7738	357.669	14.0334	0.3152	0.365166
45.	0.	0.30250	13.1853	13.8874	9.4100	357.704	15.4710	0.1933	0.413325
46.	0.	0.13045	14.0870	13.8874	10.0980	356.250	18.5903	0.0731	0.463117

PART 3: WHAFIS

WHAFIS input: CM-144-1.dat
WHAFIS output: CM-144-1.out

PART 3 COMPLETE


WHAFIS Elevation, and Total stillWater Level, transect: CM-144-1
Transect Profile
SWAN 1-D points
TSWL
Elevation (ft)
Station (ft)
0
2
4
6
8
10
12
14
16
18
20
0
20
40
60
80
100
120
140
160
180

WAVE HEIGHT COMPUTATIONS FOR FLOOD INSURANCE STUDIES (WHAFIS VERSION 4.0G, 08_2007)
Executed on: Wed Feb 26 13:21:30 2020
Input file: C:\FEMA-TransectAnalysis\LOMR-TransectAnalysis-Harpswell\Additional_Transects\3_whafis\whafis4\CM-144-1.dat
Output file: C:\FEMA-TransectAnalysis\LOMR-TransectAnalysis-Harpswell\Additional_Transects\3_whafis\whafis4\CM-144-1.out

header

THIS IS A 100-YEAR CASE
THE FOLLOWING NON-DEFAULT WIND SPEEDS ARE BEING USED
WINDIF 56.14 WINDOF 56.14 WINDVH 60.00

PART1 INPUT

IE	0.000	-15.740	1.000	1.000	8.804	11.111	10.000	56.140	0.069	0.000
OF	1.000	-15.671	0.000	8.804	0.000	0.000	0.000	0.000	0.069	0.000
OF	2.000	-15.602	0.000	8.804	0.000	0.000	0.000	0.000	0.069	0.000
OF	3.000	-15.533	0.000	8.804	0.000	0.000	0.000	0.000	0.069	0.000
OF	4.000	-15.464	0.000	8.804	0.000	0.000	0.000	0.000	0.069	0.000
OF	5.000	-15.395	0.000	8.804	0.000	0.000	0.000	0.000	0.069	0.000
OF	6.000	-15.326	0.000	8.804	0.000	0.000	0.000	0.000	0.068	0.000
OF	7.000	-15.258	0.000	8.804	0.000	0.000	0.000	0.000	0.068	0.000
OF	8.000	-15.189	0.000	8.804	0.000	0.000	0.000	0.000	0.069	0.000
OF	9.000	-15.120	0.000	8.804	0.000	0.000	0.000	0.000	0.109	0.000
OF	10.000	-14.970	0.000	8.805	0.000	0.000	0.000	0.000	0.176	0.000
OF	11.000	-14.767	0.000	8.806	0.000	0.000	0.000	0.000	0.203	0.000
OF	12.000	-14.564	0.000	8.807	0.000	0.000	0.000	0.000	0.203	0.000
OF	13.000	-14.362	0.000	8.808	0.000	0.000	0.000	0.000	0.203	0.000
OF	14.000	-14.159	0.000	8.809	0.000	0.000	0.000	0.000	0.203	0.000
OF	15.000	-13.956	0.000	8.810	0.000	0.000	0.000	0.000	0.203	0.000
OF	16.000	-13.753	0.000	8.811	0.000	0.000	0.000	0.000	0.203	0.000
OF	17.000	-13.550	0.000	8.812	0.000	0.000	0.000	0.000	0.203	0.000
OF	18.000	-13.348	0.000	8.813	0.000	0.000	0.000	0.000	0.203	0.000
OF	19.000	-13.144	0.000	8.814	0.000	0.000	0.000	0.000	0.203	0.000
OF	20.000	-12.942	0.000	8.815	0.000	0.000	0.000	0.000	0.203	0.000
OF	21.000	-12.739	0.000	8.816	0.000	0.000	0.000	0.000	0.203	0.000
OF	22.000	-12.536	0.000	8.817	0.000	0.000	0.000	0.000	0.203	0.000
OF	23.000	-12.333	0.000	8.818	0.000	0.000	0.000	0.000	0.203	0.000
OF	24.000	-12.131	0.000	8.818	0.000	0.000	0.000	0.000	0.203	0.000
OF	25.000	-11.928	0.000	8.819	0.000	0.000	0.000	0.000	0.203	0.000
OF	26.000	-11.725	0.000	8.821	0.000	0.000	0.000	0.000	0.203	0.000
OF	27.000	-11.522	0.000	8.821	0.000	0.000	0.000	0.000	0.203	0.000
OF	28.000	-11.319	0.000	8.822	0.000	0.000	0.000	0.000	0.203	0.000
OF	29.000	-11.117	0.000	8.823	0.000	0.000	0.000	0.000	0.203	0.000
OF	30.000	-10.914	0.000	8.824	0.000	0.000	0.000	0.000	0.203	0.000
OF	31.000	-10.711	0.000	8.825	0.000	0.000	0.000	0.000	0.203	0.000
OF	32.000	-10.508	0.000	8.826	0.000	0.000	0.000	0.000	0.203	0.000
OF	33.000	-10.305	0.000	8.827	0.000	0.000	0.000	0.000	0.203	0.000
OF	34.000	-10.103	0.000	8.828	0.000	0.000	0.000	0.000	0.203	0.000
OF	35.000	-9.900	0.000	8.829	0.000	0.000	0.000	0.000	0.203	0.000
OF	36.000	-9.697	0.000	8.830	0.000	0.000	0.000	0.000	0.203	0.000
OF	37.000	-9.495	0.000	8.831	0.000	0.000	0.000	0.000	0.203	0.000
OF	38.000	-9.292	0.000	8.832	0.000	0.000	0.000	0.000	0.203	0.000
OF	39.000	-9.089	0.000	8.833	0.000	0.000	0.000	0.000	0.203	0.000
OF	40.000	-8.886	0.000	8.834	0.000	0.000	0.000	0.000	0.203	0.000
OF	41.000	-8.683	0.000	8.835	0.000	0.000	0.000	0.000	0.203	0.000
OF	42.000	-8.481	0.000	8.836	0.000	0.000	0.000	0.000	0.203	0.000
OF	43.000	-8.277	0.000	8.837	0.000	0.000	0.000	0.000	0.203	0.000
OF	44.000	-8.075	0.000	8.838	0.000	0.000	0.000	0.000	0.203	0.000
OF	45.000	-7.872	0.000	8.839	0.000	0.000	0.000	0.000	0.203	0.000
OF	46.000	-7.669	0.000	8.840	0.000	0.000	0.000	0.000	0.203	0.000
OF	47.000	-7.466	0.000	8.841	0.000	0.000	0.000	0.000	0.203	0.000
OF	48.000	-7.264	0.000	8.842	0.000	0.000	0.000	0.000	0.203	0.000
OF	49.000	-7.061	0.000	8.842	0.000	0.000	0.000	0.000	0.203	0.000
OF	50.000	-6.858	0.000	8.844	0.000	0.000	0.000	0.000	0.203	0.000
OF	51.000	-6.655	0.000	8.844	0.000	0.000	0.000	0.000	0.203	0.000
OF	52.000	-6.452	0.000	8.845	0.000	0.000	0.000	0.000	0.203	0.000
OF	53.000	-6.250	0.000	8.846	0.000	0.000	0.000	0.000	0.203	0.000
OF	54.000	-6.046	0.000	8.847	0.000	0.000	0.000	0.000	0.203	0.000
OF	55.000	-5.844	0.000	8.848	0.000	0.000	0.000	0.000	0.203	0.000
OF	56.000	-5.641	0.000	8.849	0.000	0.000	0.000	0.000	0.203	0.000
OF	57.000	-5.438	0.000	8.850	0.000	0.000	0.000	0.000	0.203	0.000
OF	58.000	-5.235	0.000	8.851	0.000	0.000	0.000	0.000	0.203	0.000
OF	59.000	-5.032	0.000	8.852	0.000	0.000	0.000	0.000	0.203	0.000
OF	60.000	-4.830	0.000	8.853	0.000	0.000	0.000	0.000	0.203	0.000
OF	61.000	-4.627	0.000	8.854	0.000	0.000	0.000	0.000	0.203	0.000
OF	62.000	-4.424	0.000	8.855	0.000	0.000	0.000	0.000	0.203	0.000
OF	63.000	-4.221	0.000	8.856	0.000	0.000	0.000	0.000	0.203	0.000
OF	64.000	-4.019	0.000	8.857	0.000	0.000	0.000	0.000	0.203	0.000
OF	65.000	-3.816	0.000	8.858	0.000	0.000	0.000	0.000	0.203	0.000
OF	66.000	-3.613	0.000	8.859	0.000	0.000	0.000	0.000	0.203	0.000
OF	67.000	-3.410	0.000	8.860	0.000	0.000	0.000	0.000	0.203	0.000
OF	68.000	-3.207	0.000	8.861	0.000	0.000	0.000	0.000	0.203	0.000
OF	69.000	-3.005	0.000	8.862	0.000	0.000	0.000	0.000	0.203	0.000
OF	70.000	-2.801	0.000	8.863	0.000	0.000	0.000	0.000	0.203	0.000
OF	71.000	-2.599	0.000	8.864	0.000	0.000	0.000	0.000	0.203	0.000
OF	72.000	-2.396	0.000	8.865	0.000	0.000	0.000	0.000	0.203	0.000
OF	73.000	-2.193	0.000	8.866	0.000	0.000	0.000	0.000	0.203	0.000
OF	74.000	-1.990	0.000	8.866	0.000	0.000	0.000	0.000	0.206	0.000
OF	75.000	-1.782	0.000	8.868	0.000	0.000	0.000	0.000	0.208	0.000
OF	76.000	-1.574	0.000	8.869	0.000	0.000	0.000	0.000	0.208	0.000
OF	77.000	-1.365	0.000	8.870	0.000	0.000	0.000	0.000	0.208	0.000
OF	78.000	-1.157	0.000	8.872	0.000	0.000	0.000	0.000	0.208	0.000
OF	79.000	-0.949	0.000	8.873	0.000	0.000	0.000	0.000	0.208	0.000
OF	80.000	-0.740	0.000	8.874	0.000	0.000	0.000	0.000	0.208	0.000
OF	81.000	-0.532	0.000	8.876	0.000	0.000	0.000	0.000	0.208	0.000
OF	82.000	-0.324	0.000	8.877	0.000	0.000	0.000	0.000	0.208	0.000
OF	83.000	-0.115	0.000	8.878	0.000	0.000	0.000	0.000	-0.226	0.000
OF	91.900	-2.560	0.000	8.805	0.000	0.000	0.000	0.000	-0.205	0.000
OF	95.100	-2.593	0.000	8.811	0.000	0.000	0.000	0.000	0.061	0.000
OF	98.400	-2.162	0.000	8.810	0.000	0.000	0.000	0.000	0.131	0.000
OF	101.700	-1.732	0.000	8.810	0.000	0.000	0.000	0.000	0.131	0.000
OF	105.000	-1.301	0.000	8.811	0.000	0.000	0.000	0.000	0.131	0.000
OF	108.300	-0.870	0.000	8.813	0.000	0.000	0.000	0.000	0.180	0.000
OF	111.500	-0.131	0.000	8.812	0.000	0.000	0.000	0.000	0.281	0.000
IF	114.800	0.953	0.000	8.809	0.000	0.000	0.000	0.000	0.329	0.000
IF	118.100	2.038	0.000	8.812	0.000	0.000	0.000	0.000	0.329	0.000

IF	121.400	3.123	0.000	8.825	0.000	0.000	0.000	0.000	0.329	0.000
IF	124.700	4.207	0.000	8.845	0.000	0.000	0.000	0.000	0.329	0.000
IF	128.000	5.292	0.000	9.028	0.000	0.000	0.000	0.000	0.334	0.000
IF	131.200	6.377	0.000	9.303	0.000	0.000	0.000	0.000	0.309	0.000
IF	134.500	7.299	0.000	9.545	0.000	0.000	0.000	0.000	0.225	0.000
IF	137.800	7.858	0.000	9.698	0.000	0.000	0.000	0.000	0.169	0.000
IF	141.100	8.417	0.000	9.848	0.000	0.000	0.000	0.000	0.169	0.000
IF	144.400	8.976	0.000	10.002	0.000	0.000	0.000	0.000	0.172	0.000
IF	147.600	9.536	0.000	10.160	0.000	0.000	0.000	0.000	0.172	0.000
IF	150.900	10.095	0.000	10.324	0.000	0.000	0.000	0.000	0.168	0.000
IF	152.300	10.324	0.000	10.324	0.000	0.000	0.000	0.000	0.163	0.000
ET	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

1

	END STATION	END ELEVATION	FETCH LENGTH	SURGE ELEV 10-YEAR	SURGE ELEV 100-YEAR	INITIAL WAVE HEIGHT	INITIAL W. PERIOD		BOTTOM SLOPE	AVERAGE A-ZONES
IE	0.000	-15.740	1.000	1.000	8.804	11.111	10.000	56.140	0.069	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	1.000	-15.671	0.000	8.804	0.000	0.000	0.000	0.000	0.069	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	2.000	-15.602	0.000	8.804	0.000	0.000	0.000	0.000	0.069	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	3.000	-15.533	0.000	8.804	0.000	0.000	0.000	0.000	0.069	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	4.000	-15.464	0.000	8.804	0.000	0.000	0.000	0.000	0.069	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	5.000	-15.395	0.000	8.804	0.000	0.000	0.000	0.000	0.069	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	6.000	-15.326	0.000	8.804	0.000	0.000	0.000	0.000	0.068	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	7.000	-15.258	0.000	8.804	0.000	0.000	0.000	0.000	0.068	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	8.000	-15.189	0.000	8.804	0.000	0.000	0.000	0.000	0.069	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	9.000	-15.120	0.000	8.804	0.000	0.000	0.000	0.000	0.109	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	10.000	-14.970	0.000	8.805	0.000	0.000	0.000	0.000	0.176	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	11.000	-14.767	0.000	8.806	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	12.000	-14.564	0.000	8.807	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	13.000	-14.362	0.000	8.808	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	14.000	-14.159	0.000	8.809	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	15.000	-13.956	0.000	8.810	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	16.000	-13.753	0.000	8.811	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	17.000	-13.550	0.000	8.812	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	18.000	-13.348	0.000	8.813	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	19.000	-13.144	0.000	8.814	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	20.000	-12.942	0.000	8.815	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	21.000	-12.739	0.000	8.816	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	22.000	-12.536	0.000	8.817	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	23.000	-12.333	0.000	8.818	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	24.000	-12.131	0.000	8.818	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	25.000	-11.928	0.000	8.819	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	26.000	-11.725	0.000	8.821	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	27.000	-11.522	0.000	8.821	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES
OF	28.000	-11.319	0.000	8.822	0.000	0.000	0.000	0.000	0.203	0.000
	END STATION	END ELEVATION	NEW SURGE 10-YEAR	NEW SURGE 100-YEAR					BOTTOM SLOPE	AVERAGE A-ZONES

OF	29.000	-11.117	0.000	8.823	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	30.000	-10.914	0.000	8.824	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	31.000	-10.711	0.000	8.825	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	32.000	-10.508	0.000	8.826	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	33.000	-10.305	0.000	8.827	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	34.000	-10.103	0.000	8.828	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	35.000	-9.900	0.000	8.829	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	36.000	-9.697	0.000	8.830	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	37.000	-9.495	0.000	8.831	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	38.000	-9.292	0.000	8.832	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	39.000	-9.089	0.000	8.833	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	40.000	-8.886	0.000	8.834	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	41.000	-8.683	0.000	8.835	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	42.000	-8.481	0.000	8.836	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	43.000	-8.277	0.000	8.837	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	44.000	-8.075	0.000	8.838	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	45.000	-7.872	0.000	8.839	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	46.000	-7.669	0.000	8.840	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	47.000	-7.466	0.000	8.841	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	48.000	-7.264	0.000	8.842	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	49.000	-7.061	0.000	8.842	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	50.000	-6.858	0.000	8.844	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	51.000	-6.655	0.000	8.844	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	52.000	-6.452	0.000	8.845	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	53.000	-6.250	0.000	8.846	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	54.000	-6.046	0.000	8.847	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	55.000	-5.844	0.000	8.848	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	56.000	-5.641	0.000	8.849	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	57.000	-5.438	0.000	8.850	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	58.000	-5.235	0.000	8.851	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	59.000	-5.032	0.000	8.852	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	60.000	-4.830	0.000	8.853	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	61.000	-4.627	0.000	8.854	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	62.000	-4.424	0.000	8.855	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES

OF	63.000	-4.221	0.000	8.856	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	64.000	-4.019	0.000	8.857	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	65.000	-3.816	0.000	8.858	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	66.000	-3.613	0.000	8.859	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	67.000	-3.410	0.000	8.860	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	68.000	-3.207	0.000	8.861	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	69.000	-3.005	0.000	8.862	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	70.000	-2.801	0.000	8.863	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	71.000	-2.599	0.000	8.864	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	72.000	-2.396	0.000	8.865	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	73.000	-2.193	0.000	8.866	0.000	0.000	0.000	0.000	0.203	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	74.000	-1.990	0.000	8.866	0.000	0.000	0.000	0.000	0.206	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	75.000	-1.782	0.000	8.868	0.000	0.000	0.000	0.000	0.208	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	76.000	-1.574	0.000	8.869	0.000	0.000	0.000	0.000	0.208	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	77.000	-1.365	0.000	8.870	0.000	0.000	0.000	0.000	0.208	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	78.000	-1.157	0.000	8.872	0.000	0.000	0.000	0.000	0.208	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	79.000	-0.949	0.000	8.873	0.000	0.000	0.000	0.000	0.208	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	80.000	-0.740	0.000	8.874	0.000	0.000	0.000	0.000	0.208	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	81.000	-0.532	0.000	8.876	0.000	0.000	0.000	0.000	0.208	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	82.000	-0.324	0.000	8.877	0.000	0.000	0.000	0.000	0.208	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	83.000	-0.115	0.000	8.878	0.000	0.000	0.000	0.000	-0.226	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	91.900	-2.560	0.000	8.805	0.000	0.000	0.000	0.000	-0.205	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	95.100	-2.593	0.000	8.811	0.000	0.000	0.000	0.000	0.061	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	98.400	-2.162	0.000	8.810	0.000	0.000	0.000	0.000	0.131	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	101.700	-1.732	0.000	8.810	0.000	0.000	0.000	0.000	0.131	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	105.000	-1.301	0.000	8.811	0.000	0.000	0.000	0.000	0.131	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	108.300	-0.870	0.000	8.813	0.000	0.000	0.000	0.000	0.180	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
OF	111.500	-0.131	0.000	8.812	0.000	0.000	0.000	0.000	0.281	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
IF	114.800	0.953	0.000	8.809	0.000	0.000	0.000	0.000	0.329	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
IF	118.100	2.038	0.000	8.812	0.000	0.000	0.000	0.000	0.329	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
IF	121.400	3.123	0.000	8.825	0.000	0.000	0.000	0.000	0.329	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
IF	124.700	4.207	0.000	8.845	0.000	0.000	0.000	0.000	0.329	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
IF	128.000	5.292	0.000	9.028	0.000	0.000	0.000	0.000	0.334	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
IF	131.200	6.377	0.000	9.303	0.000	0.000	0.000	0.000	0.309	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES

IF	134.500	7.299	0.000	9.545	0.000	0.000	0.000	0.000	0.225	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
IF	137.800	7.858	0.000	9.698	0.000	0.000	0.000	0.000	0.169	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
IF	141.100	8.417	0.000	9.848	0.000	0.000	0.000	0.000	0.169	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
IF	144.400	8.976	0.000	10.002	0.000	0.000	0.000	0.000	0.172	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
IF	147.600	9.536	0.000	10.160	0.000	0.000	0.000	0.000	0.172	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
IF	150.900	10.095	0.000	10.324	0.000	0.000	0.000	0.000	0.168	0.000
	END	END	NEW SURGE	NEW SURGE					BOTTOM	AVERAGE
	STATION	ELEVATION	10-YEAR	100-YEAR					SLOPE	A-ZONES
IF	152.300	10.324	0.000	10.324	0.000	0.000	0.000	0.000	0.163	0.000

----------END OF TRANSECT----------

NOTE:
SURGE ELEVATION INCLUDES CONTRIBUTIONS FROM ASTRONOMICAL AND STORM TIDES.

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PART2: CONTROLLING WAVE HEIGHTS, SPECTRAL PEAK WAVE PERIOD, AND WAVE CREST ELEVATIONS

	LOCATION	CONTROLLING WAVE HEIGHT	SPECTRAL PEAK WAVE PERIOD	WAVE CREST ELEVATION
IE	0.00	11.11	10.00	16.58
OF	1.00	11.12	10.00	16.59
OF	2.00	11.13	10.00	16.59
OF	3.00	11.14	10.00	16.60
OF	4.00	11.15	10.00	16.61
OF	5.00	11.15	10.00	16.61
OF	6.00	11.16	10.00	16.62
OF	7.00	11.17	10.00	16.62
OF	8.00	11.18	10.00	16.63
OF	9.00	11.19	10.00	16.64
OF	10.00	11.21	10.00	16.65
OF	11.00	11.24	10.00	16.67
OF	12.00	11.26	10.00	16.69
OF	13.00	11.29	10.00	16.71
OF	14.00	11.32	10.00	16.73
OF	15.00	11.35	10.00	16.75
OF	16.00	11.38	10.00	16.77
OF	17.00	11.41	10.00	16.80
OF	18.00	11.44	10.00	16.82
OF	19.00	11.47	10.00	16.84
OF	20.00	11.50	10.00	16.86
OF	21.00	11.53	10.00	16.89
OF	22.00	11.56	10.00	16.91
OF	23.00	11.59	10.00	16.93
OF	24.00	11.62	10.00	16.96
OF	25.00	11.66	10.00	16.98
OF	26.00	11.69	10.00	17.01
OF	27.00	11.73	10.00	17.03
OF	28.00	11.76	10.00	17.05
OF	29.00	11.80	10.00	17.08
OF	30.00	11.81	10.00	17.09
OF	31.00	11.79	10.00	17.08
OF	32.00	11.76	10.00	17.06
OF	33.00	11.74	10.00	17.04
OF	34.00	11.71	10.00	17.03
OF	35.00	11.68	10.00	17.01
OF	36.00	11.66	10.00	16.99
OF	37.00	11.63	10.00	16.97
OF	38.00	11.60	10.00	16.95
OF	39.00	11.57	10.00	16.93
OF	40.00	11.54	10.00	16.91
OF	41.00	11.51	10.00	16.89
OF	42.00	11.48	10.00	16.87
OF	43.00	11.44	10.00	16.85
OF	44.00	11.41	10.00	16.83
OF	45.00	11.38	10.00	16.80
OF	46.00	11.35	10.00	16.78
OF	47.00	11.31	10.00	16.76
OF	48.00	11.28	10.00	16.74
OF	49.00	11.24	10.00	16.71
OF	50.00	11.20	10.00	16.69
OF	51.00	11.17	10.00	16.66
OF	52.00	11.13	10.00	16.63
OF	53.00	11.16	10.00	16.66
OF	54.00	11.11	10.00	16.62
OF	55.00	10.96	10.00	16.52
OF	56.00	10.82	10.00	16.42
OF	57.00	10.67	10.00	16.32
OF	58.00	10.53	10.00	16.22
OF	59.00	10.38	10.00	16.12
OF	60.00	10.24	10.00	16.02
OF	61.00	10.09	10.00	15.92
OF	62.00	9.95	10.00	15.82
OF	63.00	9.80	10.00	15.72
OF	64.00	9.66	10.00	15.62
OF	65.00	9.51	10.00	15.52
OF	66.00	9.37	10.00	15.42
OF	67.00	9.22	10.00	15.32
OF	68.00	9.08	10.00	15.21
OF	69.00	8.93	10.00	15.11
OF	70.00	8.78	10.00	15.01
OF	71.00	8.64	10.00	14.91
OF	72.00	8.49	10.00	14.81
OF	73.00	8.34	10.00	14.71
OF	74.00	8.19	10.00	14.60

OF	75.00	8.04	10.00	14.50
OF	76.00	7.89	10.00	14.39
OF	77.00	7.74	10.00	14.29
OF	78.00	7.59	10.00	14.18
OF	79.00	7.44	10.00	14.08
OF	80.00	7.28	10.00	13.97
OF	81.00	7.13	10.00	13.87
OF	82.00	6.98	10.00	13.76
OF	83.00	6.83	10.00	13.66
OF	91.90	7.23	10.00	13.87
OF	95.10	7.24	10.00	13.88
OF	98.40	7.18	10.00	13.84
OF	101.70	7.11	10.00	13.79
OF	105.00	7.04	10.00	13.74
OF	108.30	6.97	10.00	13.69
OF	111.50	6.79	10.00	13.56
IF	114.80	5.98	10.00	13.00
IF	118.10	5.18	10.00	12.44
IF	121.40	4.37	10.00	11.88
IF	124.70	3.57	10.00	11.34
IF	128.00	2.88	10.00	11.04
IF	131.20	2.26	10.00	10.89
IF	134.50	1.74	10.00	10.76
IF	137.80	1.43	10.00	10.70
IF	141.10	1.11	10.00	10.63
IF	144.40	0.80	10.00	10.56
IF	147.60	0.49	10.00	10.50
IF	150.90	0.18	10.00	10.45
IF	152.30	0.01	10.00	10.33

PART3 LOCATION OF AREAS ABOVE 100-YEAR SURGE

NO AREAS ABOVE 100-YEAR SURGE IN THIS TRANSECT

PART4 LOCATION OF SURGE CHANGES

STATION	10-YEAR SURGE	100-YEAR SURGE
10.00	1.00	8.81
11.00	1.00	8.81
12.00	1.00	8.81
13.00	1.00	8.81
14.00	1.00	8.81
15.00	1.00	8.81
16.00	1.00	8.81
17.00	1.00	8.81
18.00	1.00	8.81
19.00	1.00	8.81
20.00	1.00	8.81
21.00	1.00	8.82
22.00	1.00	8.82
23.00	1.00	8.82
25.00	1.00	8.82
26.00	1.00	8.82
28.00	1.00	8.82
29.00	1.00	8.82
30.00	1.00	8.82
31.00	1.00	8.82
32.00	1.00	8.83
33.00	1.00	8.83
34.00	1.00	8.83
35.00	1.00	8.83
36.00	1.00	8.83
37.00	1.00	8.83
38.00	1.00	8.83
39.00	1.00	8.83
40.00	1.00	8.83
41.00	1.00	8.84
42.00	1.00	8.84
43.00	1.00	8.84
44.00	1.00	8.84
45.00	1.00	8.84
46.00	1.00	8.84
47.00	1.00	8.84
48.00	1.00	8.84
50.00	1.00	8.84
52.00	1.00	8.85
53.00	1.00	8.85
54.00	1.00	8.85
55.00	1.00	8.85
56.00	1.00	8.85
57.00	1.00	8.85
58.00	1.00	8.85
59.00	1.00	8.85
60.00	1.00	8.85
61.00	1.00	8.85
62.00	1.00	8.85
63.00	1.00	8.86
64.00	1.00	8.86
65.00	1.00	8.86
66.00	1.00	8.86
67.00	1.00	8.86
68.00	1.00	8.86
69.00	1.00	8.86
70.00	1.00	8.86
71.00	1.00	8.86
72.00	1.00	8.86
73.00	1.00	8.87
75.00	1.00	8.87
76.00	1.00	8.87
77.00	1.00	8.87
78.00	1.00	8.87
79.00	1.00	8.87
80.00	1.00	8.87
81.00	1.00	8.88
82.00	1.00	8.88
83.00	1.00	8.88

91.90	1.00	8.81
95.10	1.00	8.81
98.40	1.00	8.81
105.00	1.00	8.81
108.30	1.00	8.81
111.50	1.00	8.81
114.80	1.00	8.81
118.10	1.00	8.81
121.40	1.00	8.82
124.70	1.00	8.85
128.00	1.00	9.03
131.20	1.00	9.30
134.50	1.00	9.55
137.80	1.00	9.70
141.10	1.00	9.85
144.40	1.00	10.00
147.60	1.00	10.16
150.90	1.00	10.32

PART5 LOCATION OF V ZONES

STATION OF GUTTER	LOCATION OF ZONE
127.43	WINDWARD

PART6 NUMBERED A ZONES AND V ZONES

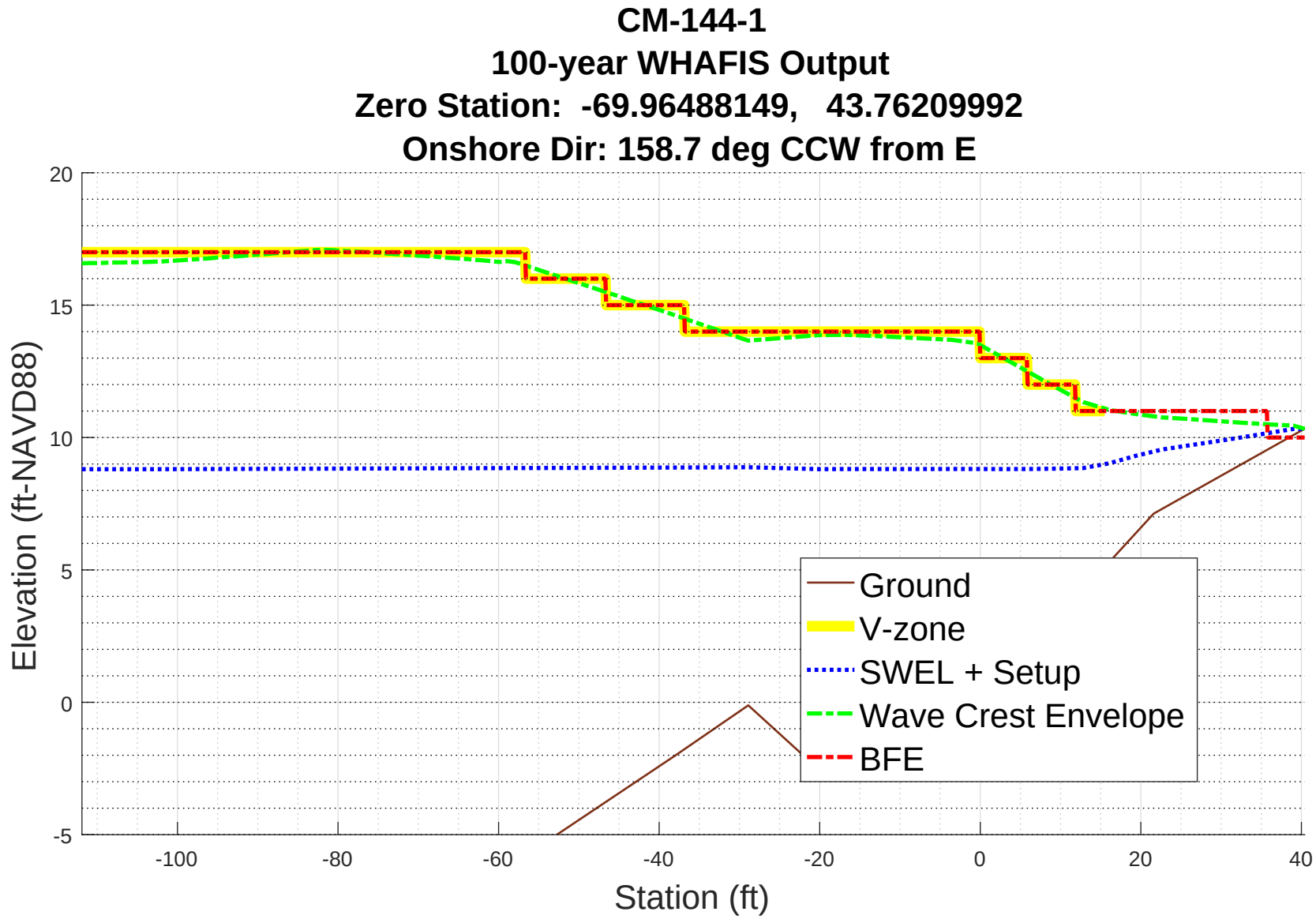
STATION OF GUTTER	ELEVATION	ZONE DESIGNATION	FHF
0.00	16.58	V22 EL=17	120
9.00	16.64	V22 EL=17	120
10.00	16.65	V22 EL=17	120
11.00	16.67	V22 EL=17	120
12.00	16.69	V22 EL=17	120
13.00	16.71	V22 EL=17	120
14.00	16.73	V22 EL=17	120
15.00	16.75	V22 EL=17	120
16.00	16.77	V22 EL=17	120
17.00	16.80	V22 EL=17	120
18.00	16.82	V22 EL=17	120
19.00	16.84	V22 EL=17	120
20.00	16.86	V22 EL=17	120
21.00	16.89	V22 EL=17	120
22.00	16.91	V22 EL=17	120
23.00	16.93	V22 EL=17	120
24.00	16.96	V22 EL=17	120
25.00	16.98	V22 EL=17	120
26.00	17.01	V22 EL=17	120
27.00	17.03	V22 EL=17	120
28.00	17.05	V22 EL=17	120
29.00	17.08	V22 EL=17	120
30.00	17.09	V22 EL=17	120
31.00	17.08	V22 EL=17	120
32.00	17.06	V22 EL=17	120
33.00	17.04	V22 EL=17	120
34.00	17.03	V22 EL=17	120
35.00	17.01	V22 EL=17	120
36.00	16.99	V22 EL=17	120
37.00	16.97	V22 EL=17	120
38.00	16.95	V22 EL=17	120
39.00	16.93	V22 EL=17	120
40.00	16.91	V22 EL=17	120
41.00	16.89	V22 EL=17	120
42.00	16.87	V22 EL=17	120
43.00	16.85	V22 EL=17	120
44.00	16.83	V22 EL=17	120
45.00	16.80	V22 EL=17	120
46.00	16.78	V22 EL=17	120
47.00	16.76		

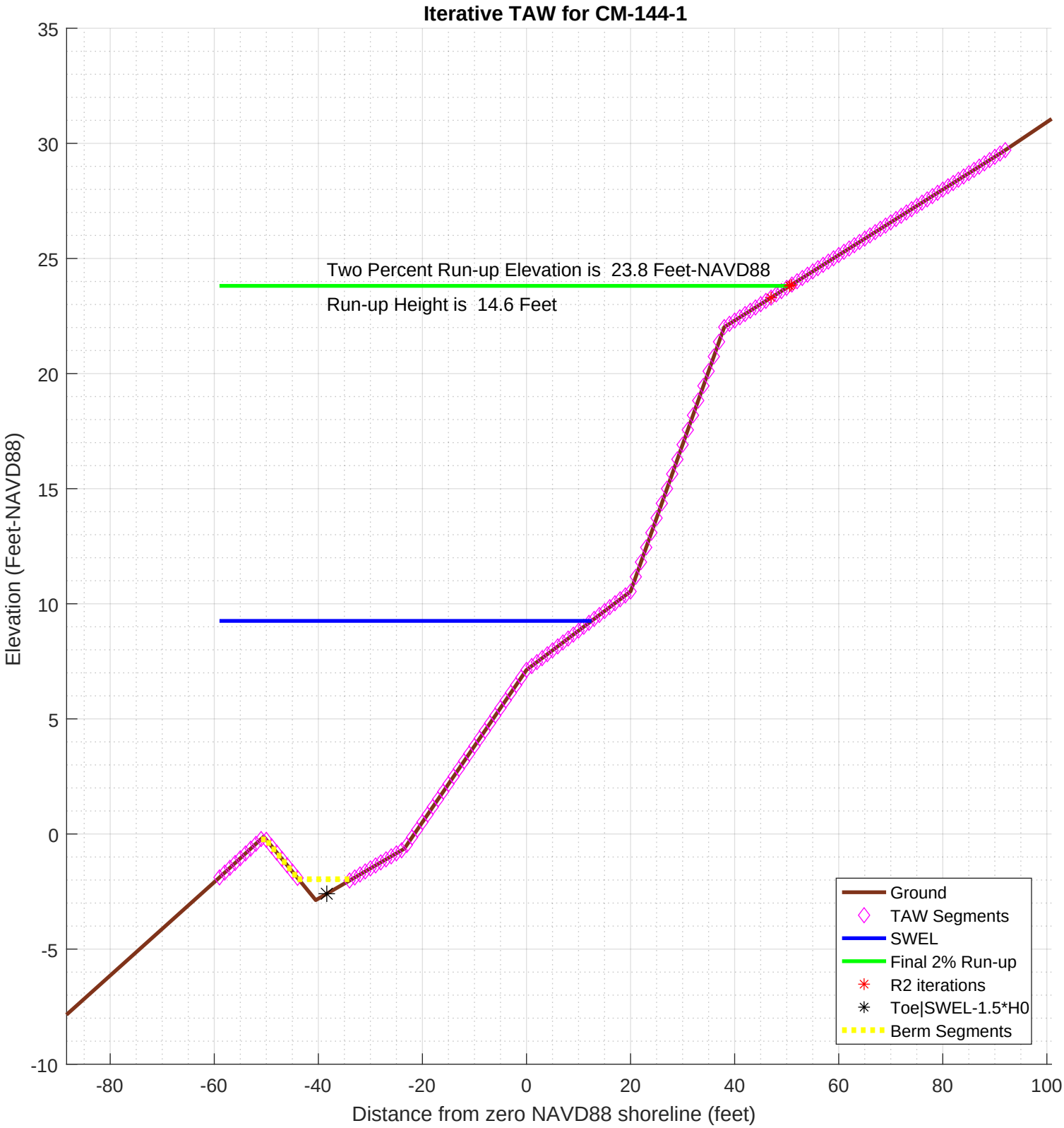
48.00	16.74	V22	EL=17	120
49.00	16.71	V22	EL=17	120
50.00	16.69	V22	EL=17	120
51.00	16.66	V22	EL=17	120
52.00	16.63	V22	EL=17	120
53.00	16.66	V22	EL=17	120
54.00	16.62	V22	EL=17	120
55.00	16.52	V22	EL=17	120
55.21	16.50	V22	EL=17	120
56.00	16.42	V22	EL=16	120
57.00	16.32	V22	EL=16	120
58.00	16.22	V22	EL=16	120
59.00	16.12	V22	EL=16	120
60.00	16.02	V22	EL=16	120
61.00	15.92	V22	EL=16	120
62.00	15.82	V22	EL=16	120
63.00	15.72	V22	EL=16	120
64.00	15.62	V22	EL=16	120
65.00	15.52	V22	EL=16	120
65.17	15.50	V22	EL=16	120
66.00	15.42	V22	EL=15	120
67.00	15.32	V22	EL=15	120
68.00	15.21	V22	EL=15	120
69.00	15.11	V22	EL=15	120
70.00	15.01	V22	EL=15	120
71.00	14.91	V22	EL=15	120
72.00	14.81	V22	EL=15	120
73.00	14.71	V22	EL=15	120
74.00	14.60	V22	EL=15	120
74.98	14.50	V22	EL=15	120
75.00	14.50	V22	EL=14	120
76.00	14.39	V22	EL=14	120
77.00	14.29	V22	EL=14	120
78.00	14.18	V22	EL=14	120
79.00	14.08	V22	EL=14	120
80.00	13.97	V22	EL=14	120
81.00	13.87	V22	EL=14	120
82.00	13.76	V22	EL=14	120
83.00	13.66	V22	EL=14	120
91.90	13.87	V22	EL=14	120
95.10	13.88	V22	EL=14	120
98.40	13.84	V22	EL=14	120
101.70	13.79	V22	EL=14	120
105.00	13.74	V22	EL=14	120
108.30	13.69	V22	EL=14	120
111.50	13.56	V22	EL=14	120
111.87	13.50	V22	EL=13	120
114.80	13.00	V22	EL=13	120
117.72	12.50	V22	EL=12	120
118.10	12.44	V22	EL=12	120
121.40	11.88			

		V22	EL=12	120
123.74	11.50			
		V22	EL=11	120
124.70	11.34			
		V22	EL=11	120
127.43	11.04			
		A19	EL=11	95
128.00	11.04			
		A19	EL=11	95
131.20	10.89			
		A19	EL=11	95
134.50	10.76			
		A19	EL=11	95
137.80	10.70			
		A19	EL=11	95
141.10	10.63			
		A19	EL=11	95
144.40	10.56			
		A19	EL=11	95
147.60	10.50			
		A19	EL=11	95
147.60	10.50			
		A19	EL=10	95
150.90	10.45			
		A19	EL=10	95
152.30	10.33			

ZONE TERMINATED AT END OF TRANSECT
PART 7 POSTSCRIPT NOTES

PS# 1 START(422364.6654,4845890.3094)
PS# 2 END(422315.9586,4845909.2882)
-1.000000e+00


CM-144-1
100-year WHAFIS Output
Zero Station: -69.96488149, 43.76209992
Onshore Dir: 158.7 deg CCW from E
Elevation (ft-NAVD88)
Station (ft)
20
15
10
5
0
-5
-100
-80
-60
-40
-20
0
20
40
Ground
V-zone
SWEL + Setup
Wave Crest Envelope
BFE


Iterative TAW for CM-144-1
Two Percent Run-up Elevation is 23.8 Feet-NAVD88
Run-up Height is 14.6 Feet
Ground
TAW Segments
SWEL
Final 2% Run-up
R2 iterations
Toe|SWEL-1.5*H0
Berm Segments
Elevation (Feet-NAVD88)
Distance from zero NAVD88 shoreline (feet)
35
30
25
20
15
10
5
0
-5
-10
-80
-60
-40
-20
0
20
40
60
80
100

```
diary on         % begin recording

% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%

%-------------------------------------------------------------------------
% CONFIG
%-------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                        % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;

gamma_berm=1;   % this may get changed automatically below
gamma_rough=1;
gamma_beta=1;
gamma_perm=1;

setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average

plotTitle='Iterative TAW for CM-144-1'

plotTitle =

Iterative TAW for CM-144-1



% END CONFIG
%------------------------------

SWEL=SWEL+setupAtToe

SWEL =

                  8.736223

SWEL_fore=SWEL+maxSetup

SWEL_fore =

                 10.255623



% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2

L0 =

          417.357062285715


% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking

% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
```

```
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0

Ztoe =

                -2.595977


% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);

% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];

sta_org=sta;  % used for plotting purposes
dep_org=dep;


% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0

Z2 =

                20.068423


% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end

toe_sta =

         -62.4868075374234


toe_sta =

         -38.3813446313046


top_sta =

          34.9443976794092

% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end

% just so the reader can tell the values aren't -999 anymore
top_sta

top_sta =

          34.9443976794092

toe_sta

toe_sta =

         -38.3813446313046




% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
```

```
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end

ans =

-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope


ans =

-!!- Setup is interpolated between setup at toe of slope and max setup


ans =

-!!-       setup is adjusted to 0.45 feet


ans =

-!!-       SWEL is adjusted to 9.26 feet


k =

     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32




% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0

    R2=R2_new
    Z2=R2+SWEL
```

```
% determine slope for this iteration
top_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
      top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
      break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end

% get the length of the slope (not accounting for berm)
Lslope=top_sta-toe_sta

% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta;   % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if  dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough

% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
```

```
    if TAW_VALID == 0
       TAW_ALWAYS_VALID=0;
    end

    if (Irb*gamma_berm < 1.8)
       R2_new=gamma*H0*1.77*Irb
    else
       R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end


    % check to see if we need to evaluate a shallow foreshore
    if berm_width > 0.25 * L0;
       disp ('!   Berm_width is greater than 1/4 wave length')
       disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1=1-w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
```

```
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
         0.977861924974634
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          23.4035594084022
R2del =
         0.739159408402184
Z2 =
           32.659493910529
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          112.060463877013
Z2 =
```

```
           32.659493910529
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.4035594084022
Z2 =
           32.659493910529
top_sta =
          112.060463877013
Lslope =
          150.441808508318
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.113000502776195
rdh_mean =
         0.810625187975784
gamma_berm =
         0.978600551028116
slope =
         0.264201087385079
Irb =
           1.96370840192932
gamma_berm =
         0.978600551028116
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
         0.978600551028116
ans =
!!! - - Iribaren number:   1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
```

```
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          23.3491540099791
R2del =
        0.0544053984230999
Z2 =
          32.6050885121059
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          111.691012577114
Z2 =
          32.6050885121059
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.3491540099791
Z2 =
          32.6050885121059
top_sta =
          111.691012577114
Lslope =
          150.072357208419
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
         0.113278689801551
rdh_mean =
         0.810625187975784
gamma_berm =
         0.978547869412482
slope =
```

```
         0.264525753135745
Irb =
          1.96612152168106
gamma_berm =
         0.978547869412482
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
         0.978547869412482
ans =
!!! - - Iribaren number:   1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          23.3530785745975
R2del =
       0.00392456461842983
Z2 =
          32.6090130767243
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          32.6090130767243
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                   8.736223
SWEL_fore =
                  10.255623
L0 =
          417.357062285715
Ztoe =
                  -2.595977
Z2 =
                  20.068423
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
top_sta =
          34.9443976794092
toe_sta =
         -38.3813446313046
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                  -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                  20.068423
H0 =
                     7.5548
Tp =
                     9.9345
T0 =
```

```
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
          0.116900842243663
rdh_mean =
          0.810625187975784
gamma_berm =
          0.977861924974634
slope =
          0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
          0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
          0.977861924974634
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          23.4035594084022
R2del =
          0.739159408402184
Z2 =
```

```
           32.659493910529
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
          -38.3813446313046
top_sta =
           112.060463877013
Z2 =
           32.659493910529
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
           9.03136363636364
R2 =
           23.4035594084022
Z2 =
           32.659493910529
top_sta =
           112.060463877013
Lslope =
           150.441808508318
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
           9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
           9.64669100212682
rdh_sum =
           1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
           9.92260850212682
rdh_sum =
           2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
           10.1985265021268
rdh_sum =
           2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
           10.4744445021268
rdh_sum =
           3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
           10.7503620021268
rdh_sum =
           4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
           11.0262795021268
rdh_sum =
           5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
           11.2205850021268
rdh_sum =
           13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
          0.113000502776195
rdh_mean =
          0.810625187975784
gamma_berm =
          0.978600551028116
slope =
          0.264201087385079
Irb =
           1.96370840192932
gamma_berm =
          0.978600551028116
gamma_perm =
```

```
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
         0.978600551028116
ans =
!!! - - Iribaren number:   1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          23.3491540099791
R2del =
         0.0544053984230999
Z2 =
          32.6050885121059
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          111.691012577114
Z2 =
          32.6050885121059
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.3491540099791
Z2 =
          32.6050885121059
top_sta =
          111.691012577114
Lslope =
          150.072357208419
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
```

```
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
         0.113278689801551
rdh_mean =
         0.810625187975784
gamma_berm =
         0.978547869412482
slope =
         0.264525753135745
Irb =
          1.96612152168106
gamma_berm =
         0.978547869412482
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
         0.978547869412482
ans =
!!! - - Iribaren number:   1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          23.3530785745975
R2del =
       0.00392456461842983
Z2 =
          32.6090130767243
Z2 =
          32.6090130767243
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%------------------------------------------------------------------------
% CONFIG
%------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                        % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=1;   % this may get changed automatically below
gamma_rough=1;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                 8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                10.255623
```

```
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
                20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
```

```
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0

    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    end

    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm_width=0;
    rdh_sum=0;
    Berm_Segs=[];
    Berm_Heights=[];
    for kk=1:length(sta)-1
       ddep=dep(kk+1)-dep(kk);
       dsta=sta(kk+1)-sta(kk);
       s=ddep/dsta;
       if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
          sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
          berm_width=berm_width+dsta;   % tally the width of all berm segments
          % compute the rdh for this segment and weight it by the segment length
          dh=SWEL-(dep(kk)+dep(kk+1))/2
          if  dh < 0
              chi=R2;
          else
              chi=2* H0;
          end
          if (dh <= R2 & dh >=-2*H0)
             rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
```

```
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
end

if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
else
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('!   Berm_width is greater than 1/4 wave length')
   disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
      ddep=dep(kk+1)-dep(kk);
      dsta=sta(kk+1)-sta(kk);
      s=ddep/dsta;
      if s < 1/15
         break
      end
      fore_toe_sta=sta(kk);
      fore_toe_dep=dep(kk);
      upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
   end
   fore_Irb=upper_slope/(sqrt(fore_H0/L0));
   fore_gamma=gamma_perm*gamma_beta*gamma_rough;
   if (fore_Irb < 1.8)
      fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
   else
      fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
   end
   if berm_width >= L0
      R2_new=fore_R2
      disp ('berm is wider than one wavelength, use full shallow foreshore solution');
   else
```

```
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1=1-w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
```

```
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
          0.116900842243663
rdh_mean =
          0.810625187975784
gamma_berm =
          0.977861924974634
slope =
          0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
          0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
          0.977861924974634
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          23.4035594084022
R2del =
          0.739159408402184
Z2 =
           32.659493910529
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          112.060463877013
Z2 =
           32.659493910529
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.4035594084022
Z2 =
           32.659493910529
top_sta =
          112.060463877013
Lslope =
          150.441808508318
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
```

```
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
          0.113000502776195
rdh_mean =
          0.810625187975784
gamma_berm =
          0.978600551028116
slope =
          0.264201087385079
Irb =
           1.96370840192932
gamma_berm =
          0.978600551028116
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
          0.978600551028116
ans =
!!! - - Iribaren number:   1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          23.3491540099791
R2del =
        0.0544053984230999
Z2 =
          32.6050885121059
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          111.691012577114
Z2 =
          32.6050885121059
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.3491540099791
Z2 =
          32.6050885121059
top_sta =
          111.691012577114
Lslope =
          150.072357208419
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
```

```
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
          0.113278689801551
rdh_mean =
          0.810625187975784
gamma_berm =
          0.978547869412482
slope =
          0.264525753135745
Irb =
           1.96612152168106
gamma_berm =
          0.978547869412482
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
          0.978547869412482
ans =
!!! - - Iribaren number:   1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          23.3530785745975
R2del =
       0.00392456461842983
Z2 =
          32.6090130767243
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          32.6090130767243
diary off
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
```

```
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%-------------------------------------------------------------------------
% CONFIG
%-------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=1;   % this may get changed automatically below
gamma_rough=1;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
               10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
         417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
               -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
               20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
          -38.3813446313046
top_sta =
           34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
```

```
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0
```

```
R2=R2_new
Z2=R2+SWEL
% determine slope for this iteration
top_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
      top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
      break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end

% get the length of the slope (not accounting for berm)
Lslope=top_sta-toe_sta
% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta;   % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if  dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
```

```
    end
    if TAW_VALID == 0
       TAW_ALWAYS_VALID=0;
    end

    if (Irb*gamma_berm < 1.8)
       R2_new=gamma*H0*1.77*Irb
    else
       R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end
    % check to see if we need to evaluate a shallow foreshore
    if berm_width > 0.25 * L0;
       disp ('!   Berm_width is greater than 1/4 wave length')
       disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1=1-w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
          -38.3813446313046
top_sta =
           34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
           9.03136363636364
R2 =
                   22.6644
Z2 =
           31.9203345021268
top_sta =
           107.041046462901
Lslope =
           145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
```

```
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
         0.977861924974634
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          23.4035594084022
R2del =
         0.739159408402184
Z2 =
           32.659493910529
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          112.060463877013
Z2 =
           32.659493910529
```

```
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.4035594084022
Z2 =
           32.659493910529
top_sta =
          112.060463877013
Lslope =
          150.441808508318
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
          0.113000502776195
rdh_mean =
          0.810625187975784
gamma_berm =
          0.978600551028116
slope =
          0.264201087385079
Irb =
           1.96370840192932
gamma_berm =
          0.978600551028116
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
          0.978600551028116
ans =
!!! - - Iribaren number:   1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
```

```
R2_new =
          23.3491540099791
R2del =
         0.0544053984230999
Z2 =
          32.6050885121059
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          111.691012577114
Z2 =
          32.6050885121059
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.3491540099791
Z2 =
          32.6050885121059
top_sta =
          111.691012577114
Lslope =
          150.072357208419
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
         0.113278689801551
rdh_mean =
         0.810625187975784
gamma_berm =
         0.978547869412482
slope =
         0.264525753135745
```

```
Irb =
          1.96612152168106
gamma_berm =
         0.978547869412482
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
         0.978547869412482
ans =
!!! - - Iribaren number:   1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          23.3530785745975
R2del =
       0.00392456461842983
Z2 =
          32.6090130767243
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          32.6090130767243
diary off
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%------------------------------------------------------------------------
% CONFIG
%------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                        % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.97855;   % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                 8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
```

```
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
                20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
```

```
 3
 4
 5
 6
 7
24
25
26
27
28
29
30
31
32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0

    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    end

    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm_width=0;
    rdh_sum=0;
    Berm_Segs=[];
    Berm_Heights=[];
    for kk=1:length(sta)-1
       ddep=dep(kk+1)-dep(kk);
       dsta=sta(kk+1)-sta(kk);
       s=ddep/dsta;
       if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
          sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
          berm_width=berm_width+dsta;   % tally the width of all berm segments
          % compute the rdh for this segment and weight it by the segment length
          dh=SWEL-(dep(kk)+dep(kk+1))/2
          if  dh < 0
              chi=R2;
          else
              chi=2* H0;
          end
          if (dh <= R2 & dh >=-2*H0)
             rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
          else
             rdh=1;
          end
          rdh_sum=rdh_sum + rdh * dsta
          Berm_Segs=[Berm_Segs, kk];
          Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
       end
       if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
```

```
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
end

if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
else
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('!   Berm_width is greater than 1/4 wave length')
   disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
      ddep=dep(kk+1)-dep(kk);
      dsta=sta(kk+1)-sta(kk);
      s=ddep/dsta;
      if s < 1/15
         break
      end
      fore_toe_sta=sta(kk);
      fore_toe_dep=dep(kk);
      upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
   end
   fore_Irb=upper_slope/(sqrt(fore_H0/L0));
   fore_gamma=gamma_perm*gamma_beta*gamma_rough;
   if (fore_Irb < 1.8)
      fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
   else
      fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
   end
   if berm_width >= L0
      R2_new=fore_R2
      disp ('berm is wider than one wavelength, use full shallow foreshore solution');
   else
      w2=(berm_width-0.25*L0)/(0.75*L0)
      w1=1-w2
      R2_new=w2*fore_R2 + w1*R2_new
   end
end % end berm width check
% convergence criterion
R2del=abs(R2-R2_new)
R2_all(iter)=R2_new;
```

```
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
```

```
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
         14.0421356450413
R2del =
         8.62226435495869
Z2 =
         23.2980701471681
top_sta =
         46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         46.9993332993712
Z2 =
         23.2980701471681
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
         9.03136363636364
R2 =
         14.0421356450413
Z2 =
         23.2980701471681
top_sta =
         46.9993332993712
Lslope =
         85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
```

```
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
          0.199108280843155
rdh_mean =
          0.810625187975784
gamma_berm =
          0.962293906742863
slope =
          0.378674911258111
Irb =
           2.81454975146854
gamma_berm =
          0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
          0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
          0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
```

```
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z2 =
          23.8053594702738
top_sta =
```

```
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
```

```
          23.8092710365979
diary off
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%------------------------------------------------------------------------
% CONFIG
%------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                        % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381;   % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
               10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
               -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
               20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
```

```
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
```

```
iter=iter+1;
sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
% elevation of toe of slope
Ztoe
% station of toe slope (relative to 0-NAVD88 shoreline
toe_sta
% station of top of slope/extent of 2% run-up
top_sta
% elevation of top of slope/extent of 2% run-up
Z2
% incident significant wave height
H0
% incident spectral peak wave period
Tp
% incident spectral mean wave period
T0

R2=R2_new
Z2=R2+SWEL
% determine slope for this iteration
top_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
      top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
      break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end

% get the length of the slope (not accounting for berm)
Lslope=top_sta-toe_sta
% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta;   % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if  dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
```

```
    gamma_rough
    gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
    % check validity
    TAW_VALID=1;
    if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
       sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
       TAW_VALID=0;
    else
       sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
    end
    islope=1/slope;
    if (slope < 1/8 | slope > 1)
       sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
       TAW_VALID=0;
    else
       sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
    end
    if TAW_VALID == 0
       TAW_ALWAYS_VALID=0;
    end

    if (Irb*gamma_berm < 1.8)
       R2_new=gamma*H0*1.77*Irb
    else
       R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end
    % check to see if we need to evaluate a shallow foreshore
    if berm_width > 0.25 * L0;
       disp ('!   Berm_width is greater than 1/4 wave length')
       disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1=1-w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
```

```
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
          0.116900842243663
rdh_mean =
          0.810625187975784
gamma_berm =
          0.977861924974634
slope =
          0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
          0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.8
gamma =
          0.782289539979707
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
```

```
R2_new =
          18.7228475267218
R2del =
          3.94155247327825
Z2 =
          27.9787820288486
top_sta =
          79.8990878658385
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          79.8990878658385
Z2 =
          27.9787820288486
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          18.7228475267218
Z2 =
          27.9787820288486
top_sta =
          79.8990878658385
Lslope =
          118.280432497143
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.143726224541922
rdh_mean =
         0.810625187975784
gamma_berm =
         0.972781873244423
```

```
slope =
         0.301882192591457
Irb =
          2.24377803987103
gamma_berm =
         0.972781873244423
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.8
gamma =
         0.778225498595539
ans =
!!! - - Iribaren number:   2.18 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          19.0011704443444
R2del =
          0.27832291762261
Z2 =
          28.2571049464712
top_sta =
          81.8553611847108
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          81.8553611847108
Z2 =
          28.2571049464712
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          19.0011704443444
Z2 =
          28.2571049464712
top_sta =
          81.8553611847108
Lslope =
          120.236705816015
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
```

```
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
          0.14138777243293
rdh_mean =
         0.810625187975784
gamma_berm =
         0.973224717172991
slope =
         0.298857675693918
Irb =
          2.22129793086672
gamma_berm =
         0.973224717172991
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.8
gamma =
         0.778579773738393
ans =
!!! - - Iribaren number:   2.16 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          18.9781084739222
R2del =
       0.0230619704221695
Z2 =
          28.234042976049
top_sta =
          81.6932634393908
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          81.6932634393908
Z2 =
          28.234042976049
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          18.9781084739222
Z2 =
          28.234042976049
top_sta =
          81.6932634393908
Lslope =
          120.074608070695
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
```

```
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.141578642421977
rdh_mean =
         0.810625187975784
gamma_berm =
         0.973188571204694
slope =
         0.299103926302623
Irb =
          2.22312822003805
gamma_berm =
         0.973188571204694
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.8
gamma =
         0.778550856963756
ans =
!!! - - Iribaren number:   2.16 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          18.9800034263996
R2del =
        0.0018949524774321
Z2 =
          28.2359379285264
top_sta =
          81.7065826622698
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          28.2359379285264
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                   8.736223
SWEL_fore =
                  10.255623
L0 =
          417.357062285715
Ztoe =
                  -2.595977
Z2 =
                  20.068423
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
top_sta =
          34.9443976794092
toe_sta =
         -38.3813446313046
ans =
```

```
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
          -38.3813446313046
top_sta =
           34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
           9.03136363636364
R2 =
                  22.6644
Z2 =
           31.9203345021268
top_sta =
           107.041046462901
Lslope =
           145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
           9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
           9.64669100212682
rdh_sum =
           1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
           9.92260850212682
rdh_sum =
           2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
           10.1985265021268
rdh_sum =
           2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
           10.4744445021268
rdh_sum =
           3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
           10.7503620021268
rdh_sum =
           4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
           11.0262795021268
rdh_sum =
           5.32809529031497
```

```
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
          0.116900842243663
rdh_mean =
          0.810625187975784
gamma_berm =
          0.977861924974634
slope =
          0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
          0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.8
gamma =
          0.782289539979707
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          18.7228475267218
R2del =
          3.94155247327825
Z2 =
          27.9787820288486
top_sta =
          79.8990878658385
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          79.8990878658385
Z2 =
          27.9787820288486
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          18.7228475267218
Z2 =
          27.9787820288486
top_sta =
          79.8990878658385
Lslope =
          118.280432497143
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
```

```
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.143726224541922
rdh_mean =
         0.810625187975784
gamma_berm =
         0.972781873244423
slope =
         0.301882192591457
Irb =
          2.24377803987103
gamma_berm =
         0.972781873244423
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.8
gamma =
         0.778225498595539
ans =
!!! - - Iribaren number:   2.18 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          19.0011704443444
R2del =
          0.27832291762261
Z2 =
          28.2571049464712
top_sta =
          81.8553611847108
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          81.8553611847108
Z2 =
          28.2571049464712
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          19.0011704443444
Z2 =
          28.2571049464712
top_sta =
          81.8553611847108
Lslope =
          120.236705816015
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
```

```
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
          0.14138777243293
rdh_mean =
         0.810625187975784
gamma_berm =
         0.973224717172991
slope =
         0.298857675693918
Irb =
          2.22129793086672
gamma_berm =
         0.973224717172991
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.8
gamma =
         0.778579773738393
ans =
!!! - - Iribaren number:   2.16 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          18.9781084739222
R2del =
        0.0230619704221695
Z2 =
          28.234042976049
top_sta =
          81.6932634393908
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          81.6932634393908
Z2 =
          28.234042976049
H0 =
                   7.5548
```

```
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          18.9781084739222
Z2 =
           28.234042976049
top_sta =
          81.6932634393908
Lslope =
          120.074608070695
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.141578642421977
rdh_mean =
         0.810625187975784
gamma_berm =
         0.973188571204694
slope =
         0.299103926302623
Irb =
          2.22312822003805
gamma_berm =
         0.973188571204694
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.8
gamma =
         0.778550856963756
ans =
!!! - - Iribaren number:   2.16 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          18.9800034263996
```

```
R2del =
       0.0018949524774321
Z2 =
         28.2359379285264
top_sta =
         81.7065826622698
Z2 =
         28.2359379285264
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                  8.736223
SWEL_fore =
                 10.255623
L0 =
         417.357062285715
Ztoe =
                 -2.595977
Z2 =
                 20.068423
toe_sta =
        -62.4868075374234
toe_sta =
        -38.3813446313046
top_sta =
         34.9443976794092
top_sta =
         34.9443976794092
toe_sta =
        -38.3813446313046
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                 -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
                   22.6644
Z2 =
         31.9203345021268
top_sta =
         107.041046462901
Lslope =
         145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
```

```
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
          0.116900842243663
rdh_mean =
          0.810625187975784
gamma_berm =
          0.977861924974634
slope =
          0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
          0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
```

```
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
```

```
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
          0.190419663210427
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963939312073811
slope =
          0.365932410915933
Irb =
           2.71983948652912
gamma_berm =
          0.963939312073811
gamma_perm =
```

```
     1
gamma_beta =
     1
gamma_rough =
                    0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
         14.549424968147
R2del =
       0.0469753852659309
Z2 =
         23.8053594702738
top_sta =
         50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.5649673529656
Z2 =
         23.8053594702738
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
         9.03136363636364
R2 =
         14.549424968147
Z2 =
         23.8053594702738
top_sta =
         50.5649673529656
Lslope =
         88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
```

```
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
Z2 =
          23.8092710365979
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%-------------------------------------------------------------------------
% CONFIG
%-------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                        % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381;   % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
```

```
                 8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
         417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
                20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
```

```
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0

    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    end

    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm_width=0;
    rdh_sum=0;
    Berm_Segs=[];
    Berm_Heights=[];
    for kk=1:length(sta)-1
       ddep=dep(kk+1)-dep(kk);
       dsta=sta(kk+1)-sta(kk);
       s=ddep/dsta;
       if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
          sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
          berm_width=berm_width+dsta;   % tally the width of all berm segments
          % compute the rdh for this segment and weight it by the segment length
          dh=SWEL-(dep(kk)+dep(kk+1))/2
          if  dh < 0
              chi=R2;
          else
```

```
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
end

if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
else
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('!   Berm_width is greater than 1/4 wave length')
   disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
      ddep=dep(kk+1)-dep(kk);
      dsta=sta(kk+1)-sta(kk);
      s=ddep/dsta;
      if s < 1/15
         break
      end
      fore_toe_sta=sta(kk);
      fore_toe_dep=dep(kk);
      upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
   end
   fore_Irb=upper_slope/(sqrt(fore_H0/L0));
   fore_gamma=gamma_perm*gamma_beta*gamma_rough;
   if (fore_Irb < 1.8)
      fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
   else
      fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
   end
```

```
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1=1-w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
```

```
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
```

```
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
          0.199108280843155
rdh_mean =
          0.810625187975784
gamma_berm =
          0.962293906742863
slope =
          0.378674911258111
Irb =
           2.81454975146854
gamma_berm =
          0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
          0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
          0.554264708371569
Z2 =
           23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
```

```
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
```

```
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
           14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
```

```
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          23.8092710365979
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                   8.736223
SWEL_fore =
                  10.255623
L0 =
          417.357062285715
Ztoe =
                 -2.595977
Z2 =
                  20.068423
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
top_sta =
          34.9443976794092
toe_sta =
         -38.3813446313046
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                  20.068423
H0 =
                     7.5548
Tp =
                     9.9345
T0 =
          9.03136363636364
R2 =
                    22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
```

```
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
         14.0421356450413
R2del =
         8.62226435495869
Z2 =
         23.2980701471681
top_sta =
         46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         46.9993332993712
Z2 =
         23.2980701471681
H0 =
```

```
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
          0.199108280843155
rdh_mean =
          0.810625187975784
gamma_berm =
          0.962293906742863
slope =
          0.378674911258111
Irb =
           2.81454975146854
gamma_berm =
          0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
```

```
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
```

```
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                  -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                     7.5548
Tp =
                     9.9345
T0 =
          9.03136363636364
R2 =
           14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
```

```
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
          0.191126530383928
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963805449235703
slope =
          0.366958857822288
Irb =
           2.72746868455436
gamma_berm =
          0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
Z2 =
          23.8092710365979
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                   8.736223
SWEL_fore =
                  10.255623
L0 =
          417.357062285715
Ztoe =
                  -2.595977
Z2 =
                  20.068423
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
top_sta =
          34.9443976794092
toe_sta =
         -38.3813446313046
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
```

```
    31
    32
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
```

```
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
```

```
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
          0.199108280843155
rdh_mean =
          0.810625187975784
gamma_berm =
          0.962293906742863
slope =
          0.378674911258111
Irb =
           2.81454975146854
gamma_berm =
          0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
          0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
          0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
```

```
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.549424968147
R2del =
       0.0469753852659309
Z2 =
         23.8053594702738
top_sta =
         50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.5649673529656
Z2 =
         23.8053594702738
H0 =
                  7.5548
Tp =
                  9.9345
T0 =
         9.03136363636364
R2 =
          14.549424968147
Z2 =
         23.8053594702738
top_sta =
         50.5649673529656
Lslope =
         88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
         9.64669100212682
```

```
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
Z2 =
          23.8092710365979
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
```

```
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%-------------------------------------------------------------------------
% CONFIG
%-------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381;   % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
               10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
         417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
               -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
               20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
          -38.3813446313046
top_sta =
           34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
```

```
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0
```

```
R2=R2_new
Z2=R2+SWEL
% determine slope for this iteration
top_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
      top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
      break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end

% get the length of the slope (not accounting for berm)
Lslope=top_sta-toe_sta
% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta;   % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if  dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
```

```
    end
    if TAW_VALID == 0
       TAW_ALWAYS_VALID=0;
    end

    if (Irb*gamma_berm < 1.8)
       R2_new=gamma*H0*1.77*Irb
    else
       R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end
    % check to see if we need to evaluate a shallow foreshore
    if berm_width > 0.25 * L0;
       disp ('!   Berm_width is greater than 1/4 wave length')
       disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1=1-w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
          -38.3813446313046
top_sta =
           34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
           9.03136363636364
R2 =
                   22.6644
Z2 =
           31.9203345021268
top_sta =
           107.041046462901
Lslope =
           145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
```

```
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
```

```
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
```

```
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
```

```
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
```

```
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.553336534471
R2del =
       0.00391156632409739
Z2 =
         23.8092710365979
top_sta =
         50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
         23.8092710365979
diary off
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%-------------------------------------------------------------------------
% CONFIG
%-------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                        % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381;   % this may get changed automatically below
```

```
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
               10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
               -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
               20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
```

```
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0

    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    end

    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm_width=0;
    rdh_sum=0;
    Berm_Segs=[];
    Berm_Heights=[];
```

```
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta;   % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if  dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
end

if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
else
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('!   Berm_width is greater than 1/4 wave length')
   disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
      ddep=dep(kk+1)-dep(kk);
      dsta=sta(kk+1)-sta(kk);
      s=ddep/dsta;
      if s < 1/15
         break
```

```
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1=1-w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
```

```
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
          0.116900842243663
rdh_mean =
          0.810625187975784
gamma_berm =
          0.977861924974634
slope =
          0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
          0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
```

```
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
```

```
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
```

```
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
           14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
```

```
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          23.8092710365979
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                   8.736223
SWEL_fore =
                  10.255623
L0 =
          417.357062285715
Ztoe =
                  -2.595977
Z2 =
                  20.068423
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
top_sta =
          34.9443976794092
toe_sta =
         -38.3813446313046
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                  -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                  20.068423
H0 =
                     7.5548
Tp =
                     9.9345
T0 =
          9.03136363636364
R2 =
```

```
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
```

```
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
```

```
     1
gamma_beta =
     1
gamma_rough =
                    0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
```

```
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
           14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
```

```
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
          0.191126530383928
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963805449235703
slope =
          0.366958857822288
Irb =
           2.72746868455436
gamma_berm =
          0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
          0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
Z2 =
          23.8092710365979
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%-------------------------------------------------------------------------
% CONFIG
%-------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                     % third colunm is 0 for excluded points
```

```
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381;   % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                 8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
         417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
               -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
                20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
```

```
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0

    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    end

    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
```

```
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta;   % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if  dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
end

if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
else
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('!   Berm_width is greater than 1/4 wave length')
   disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
```

```
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1=1-w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
```

```
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
          0.116900842243663
rdh_mean =
          0.810625187975784
gamma_berm =
          0.977861924974634
slope =
          0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
          0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
```

```
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
```

```
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
          0.190419663210427
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963939312073811
slope =
          0.365932410915933
Irb =
           2.71983948652912
gamma_berm =
          0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
```

```
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
           23.8053594702738
top_sta =
           50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                 -2.595977
toe_sta =
          -38.3813446313046
top_sta =
           50.5649673529656
Z2 =
           23.8053594702738
H0 =
                     7.5548
Tp =
                     9.9345
T0 =
           9.03136363636364
R2 =
           14.549424968147
Z2 =
           23.8053594702738
top_sta =
           50.5649673529656
Lslope =
           88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
           9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
           9.64669100212682
rdh_sum =
           1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
           9.92260850212682
rdh_sum =
           2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
           10.1985265021268
rdh_sum =
           2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
           10.4744445021268
rdh_sum =
           3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
           10.7503620021268
rdh_sum =
           4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
           11.0262795021268
rdh_sum =
           5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
           11.2205850021268
rdh_sum =
           13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
          0.191126530383928
rdh_mean =
          0.810625187975784
gamma_berm =
```

```
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          23.8092710365979
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                   8.736223
SWEL_fore =
                  10.255623
L0 =
          417.357062285715
Ztoe =
                  -2.595977
Z2 =
                  20.068423
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
top_sta =
          34.9443976794092
toe_sta =
         -38.3813446313046
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                  -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                  20.068423
H0 =
```

```
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
          0.116900842243663
rdh_mean =
          0.810625187975784
gamma_berm =
          0.977861924974634
slope =
          0.268771755517362
Irb =
            1.9976804779061
gamma_berm =
          0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
```

```
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
```

```
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                  -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                     7.5548
Tp =
                     9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
```

```
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
          0.190419663210427
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963939312073811
slope =
          0.365932410915933
Irb =
           2.71983948652912
gamma_berm =
          0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
           14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
```

```
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
          0.191126530383928
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963805449235703
slope =
          0.366958857822288
Irb =
           2.72746868455436
gamma_berm =
          0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
          0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
Z2 =
          23.8092710365979
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
```

```
%
%------------------------------------------------------------------------
% CONFIG
%------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                    % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381;   % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
               10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
               -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
               20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
```

```
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0

    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
```

```
   top_sta=sta(end)+dy/S(end)
end

% get the length of the slope (not accounting for berm)
Lslope=top_sta-toe_sta
% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta;   % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if  dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
end

if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
else
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('!   Berm_width is greater than 1/4 wave length')
```

```
       disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1=1-w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
          -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
```

```
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
```

```
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
```

```
                -2.595977
toe_sta =
       -38.3813446313046
top_sta =
         50.8951497883595
Z2 =
         23.8523348555397
H0 =
                  7.5548
Tp =
                  9.9345
T0 =
         9.03136363636364
R2 =
         14.5964003534129
Z2 =
         23.8523348555397
top_sta =
         50.8951497883595
Lslope =
         89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
        0.190419663210427
rdh_mean =
        0.810625187975784
gamma_berm =
        0.963939312073811
slope =
        0.365932410915933
Irb =
         2.71983948652912
gamma_berm =
        0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
```

```
                     0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
```

```
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.553336534471
R2del =
       0.00391156632409739
Z2 =
           23.8092710365979
top_sta =
           50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
           23.8092710365979
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                    8.736223
SWEL_fore =
                   10.255623
L0 =
          417.357062285715
Ztoe =
                   -2.595977
Z2 =
                   20.068423
toe_sta =
          -62.4868075374234
toe_sta =
          -38.3813446313046
top_sta =
           34.9443976794092
top_sta =
           34.9443976794092
toe_sta =
          -38.3813446313046
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                   -2.595977
toe_sta =
```

```
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
```

```
          0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
```

```
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
```

```
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
          0.190419663210427
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963939312073811
slope =
          0.365932410915933
Irb =
           2.71983948652912
gamma_berm =
          0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
           14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
```

```
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
          0.191126530383928
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963805449235703
slope =
          0.366958857822288
Irb =
           2.72746868455436
gamma_berm =
          0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
          0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
Z2 =
          23.8092710365979
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
```

```
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%-------------------------------------------------------------------------
% CONFIG
%-------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                        % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381;   % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
               10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
               -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
               20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
```

```
top_sta
top_sta =
         34.9443976794092
toe_sta
toe_sta =
        -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0

    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
```

```
      top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
      break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end

% get the length of the slope (not accounting for berm)
Lslope=top_sta-toe_sta
% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta;   % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if  dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
end

if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
```

```
    else
       R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end
    % check to see if we need to evaluate a shallow foreshore
    if berm_width > 0.25 * L0;
       disp ('!   Berm_width is greater than 1/4 wave length')
       disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1=1-w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
```

```
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
```

```
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
```

```
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
```

```
         0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
```

```
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.553336534471
R2del =
       0.00391156632409739
Z2 =
           23.8092710365979
top_sta =
           50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
           23.8092710365979
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                    8.736223
SWEL_fore =
                   10.255623
L0 =
          417.357062285715
Ztoe =
                   -2.595977
Z2 =
                   20.068423
toe_sta =
          -62.4868075374234
toe_sta =
          -38.3813446313046
top_sta =
           34.9443976794092
top_sta =
           34.9443976794092
toe_sta =
          -38.3813446313046
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
```

```
    32
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
          0.116900842243663
rdh_mean =
          0.810625187975784
gamma_berm =
          0.977861924974634
slope =
          0.268771755517362
Irb =
            1.9976804779061
gamma_berm =
          0.977861924974634
gamma_perm =
```

```
     1
gamma_beta =
     1
gamma_rough =
                    0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
```

```
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
```

```
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
          0.190419663210427
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963939312073811
slope =
          0.365932410915933
Irb =
           2.71983948652912
gamma_berm =
          0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.549424968147
R2del =
         0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!------------------ STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                     7.5548
Tp =
                     9.9345
T0 =
          9.03136363636364
R2 =
           14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
```

```
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
Z2 =
          23.8092710365979
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                   8.736223
SWEL_fore =
                  10.255623
L0 =
          417.357062285715
Ztoe =
                  -2.595977
Z2 =
                  20.068423
toe_sta =
         -62.4868075374234
toe_sta =
```

```
         -38.3813446313046
top_sta =
          34.9443976794092
top_sta =
          34.9443976794092
toe_sta =
         -38.3813446313046
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
```

```
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
         14.0421356450413
R2del =
         8.62226435495869
Z2 =
         23.2980701471681
top_sta =
         46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         46.9993332993712
Z2 =
         23.2980701471681
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
         9.03136363636364
R2 =
         14.0421356450413
Z2 =
         23.2980701471681
top_sta =
         46.9993332993712
Lslope =
         85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
         9.92260850212682
```

```
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
               -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
```

```
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
          0.190419663210427
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963939312073811
slope =
          0.365932410915933
Irb =
           2.71983948652912
gamma_berm =
          0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
          0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
```

```
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
           14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
```

```
gamma =
        0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
Z2 =
          23.8092710365979
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%------------------------------------------------------------------------
% CONFIG
%------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                     % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381;   % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                 8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
```

```
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
                20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
```

```
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0

    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    end

    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm_width=0;
    rdh_sum=0;
    Berm_Segs=[];
    Berm_Heights=[];
    for kk=1:length(sta)-1
       ddep=dep(kk+1)-dep(kk);
       dsta=sta(kk+1)-sta(kk);
       s=ddep/dsta;
       if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
          sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
          berm_width=berm_width+dsta;   % tally the width of all berm segments
          % compute the rdh for this segment and weight it by the segment length
          dh=SWEL-(dep(kk)+dep(kk+1))/2
          if  dh < 0
              chi=R2;
          else
              chi=2* H0;
          end
          if (dh <= R2 & dh >=-2*H0)
             rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
          else
             rdh=1;
          end
          rdh_sum=rdh_sum + rdh * dsta
          Berm_Segs=[Berm_Segs, kk];
          Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
       end
       if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
          break
       end
    end
    sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
    berm_width
    rB=berm_width/Lslope
    if (berm_width > 0)
       rdh_mean=rdh_sum/berm_width
    else
       rdh_mean=1
    end
```

```
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
end

if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
else
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('!   Berm_width is greater than 1/4 wave length')
   disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
      ddep=dep(kk+1)-dep(kk);
      dsta=sta(kk+1)-sta(kk);
      s=ddep/dsta;
      if s < 1/15
         break
      end
      fore_toe_sta=sta(kk);
      fore_toe_dep=dep(kk);
      upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
   end
   fore_Irb=upper_slope/(sqrt(fore_H0/L0));
   fore_gamma=gamma_perm*gamma_beta*gamma_rough;
   if (fore_Irb < 1.8)
      fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
   else
      fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
   end
   if berm_width >= L0
      R2_new=fore_R2
      disp ('berm is wider than one wavelength, use full shallow foreshore solution');
   else
      w2=(berm_width-0.25*L0)/(0.75*L0)
      w1=1-w2
      R2_new=w2*fore_R2 + w1*R2_new
   end
end % end berm width check
% convergence criterion
R2del=abs(R2-R2_new)
R2_all(iter)=R2_new;
% get the new top station (for plot purposes)
Z2=R2_new+SWEL
top_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
      top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
      break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
```

```
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
```

```
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
```

```
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
          0.199108280843155
rdh_mean =
          0.810625187975784
gamma_berm =
          0.962293906742863
slope =
          0.378674911258111
Irb =
           2.81454975146854
gamma_berm =
          0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.5964003534129
R2del =
          0.554264708371569
Z2 =
           23.8523348555397
top_sta =
           50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                 -2.595977
toe_sta =
          -38.3813446313046
top_sta =
           50.8951497883595
Z2 =
           23.8523348555397
H0 =
                     7.5548
Tp =
                     9.9345
T0 =
          9.03136363636364
R2 =
           14.5964003534129
Z2 =
           23.8523348555397
top_sta =
           50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
```

```
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
          0.190419663210427
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963939312073811
slope =
          0.365932410915933
Irb =
           2.71983948652912
gamma_berm =
          0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.549424968147
R2del =
         0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
           14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
```

```
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          23.8092710365979
diary off
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
```

```
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%-------------------------------------------------------------------------
% CONFIG
%-------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                        % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381;   % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                 8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
                20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
```

```
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!---------------- STARTING ITERATION %d ----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
```

```
H0
% incident spectral peak wave period
Tp
% incident spectral mean wave period
T0

R2=R2_new
Z2=R2+SWEL
% determine slope for this iteration
top_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
      top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
      break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end

% get the length of the slope (not accounting for berm)
Lslope=top_sta-toe_sta
% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta;   % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if  dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
```

```
    if (slope < 1/8 | slope > 1)
       sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
       TAW_VALID=0;
    else
       sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
    end
    if TAW_VALID == 0
       TAW_ALWAYS_VALID=0;
    end

    if (Irb*gamma_berm < 1.8)
       R2_new=gamma*H0*1.77*Irb
    else
       R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end
    % check to see if we need to evaluate a shallow foreshore
    if berm_width > 0.25 * L0;
       disp ('!   Berm_width is greater than 1/4 wave length')
       disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1=1-w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
```

```
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
```

```
                -2.595977
toe_sta =
       -38.3813446313046
top_sta =
         46.9993332993712
Z2 =
         23.2980701471681
H0 =
                  7.5548
Tp =
                  9.9345
T0 =
         9.03136363636364
R2 =
         14.0421356450413
Z2 =
         23.2980701471681
top_sta =
         46.9993332993712
Lslope =
         85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
        0.199108280843155
rdh_mean =
        0.810625187975784
gamma_berm =
        0.962293906742863
slope =
        0.378674911258111
Irb =
         2.81454975146854
gamma_berm =
        0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
```

```
                    0.6
gamma =
        0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
        14.5964003534129
R2del =
        0.554264708371569
Z2 =
        23.8523348555397
top_sta =
        50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
       -38.3813446313046
top_sta =
        50.8951497883595
Z2 =
        23.8523348555397
H0 =
                  7.5548
Tp =
                  9.9345
T0 =
        9.03136363636364
R2 =
        14.5964003534129
Z2 =
        23.8523348555397
top_sta =
        50.8951497883595
Lslope =
        89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
        9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
        9.64669100212682
rdh_sum =
        1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
        9.92260850212682
rdh_sum =
        2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
        10.1985265021268
rdh_sum =
        2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
        10.4744445021268
rdh_sum =
        3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
        10.7503620021268
rdh_sum =
        4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
        11.0262795021268
rdh_sum =
        5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
        11.2205850021268
rdh_sum =
        13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
```

```
    17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
           14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
```

```
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
          0.191126530383928
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963805449235703
slope =
          0.366958857822288
Irb =
           2.72746868455436
gamma_berm =
          0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
          0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          23.8092710365979
diary off
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%------------------------------------------------------------------------
% CONFIG
%------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                        % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
```

```
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381;   % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                  8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                 10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                 -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
                 20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
```

```
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0

    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    end

    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
```

```
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta;   % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if  dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
end

if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
else
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('!   Berm_width is greater than 1/4 wave length')
   disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
```

```
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1=1-w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
```

```
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
          0.116900842243663
rdh_mean =
          0.810625187975784
gamma_berm =
          0.977861924974634
slope =
          0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
          0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
```

```
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
```

```
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
          0.190419663210427
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963939312073811
slope =
          0.365932410915933
Irb =
           2.71983948652912
gamma_berm =
          0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
```

```
R2_new =
          14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
```

```
slope =
        0.366958857822288
Irb =
         2.72746868455436
gamma_berm =
        0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
        0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          23.8092710365979
diary off
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20200220
%
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
%
% references:
%
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
%
% FEMA. 2007,  Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%
%
%
%------------------------------------------------------------------------
% CONFIG
%------------------------------------------------------------------------
fname='inpfiles/CM-144-1sta_ele_include.csv';   % file with station, elevation, include
                                        % third colunm is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043;  % 100-yr still water level including wave setup.
H0=7.5548;    % significant wave height at toe of structure
Tp=9.9345;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381;   % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                  8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                 10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
```

```
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;  % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
                20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
    if  ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))    % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-       setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-       SWEL is adjusted to %4.2f feet',SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases.  However the user may want to consider:\n')
   sprintf('-!!-   1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.45 feet
ans =
```

```
-!!-       SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01;  % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!----------------- STARTING ITERATION %d -----------------!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0

    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    end

    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm_width=0;
    rdh_sum=0;
    Berm_Segs=[];
    Berm_Heights=[];
    for kk=1:length(sta)-1
       ddep=dep(kk+1)-dep(kk);
       dsta=sta(kk+1)-sta(kk);
       s=ddep/dsta;
       if  (s < 1/15)     % count it as a berm if slope is flatter than 1:15 (see TAW manual)
          sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
          berm_width=berm_width+dsta;   % tally the width of all berm segments
          % compute the rdh for this segment and weight it by the segment length
          dh=SWEL-(dep(kk)+dep(kk+1))/2
          if  dh < 0
              chi=R2;
          else
              chi=2* H0;
          end
          if (dh <= R2 & dh >=-2*H0)
             rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
          else
             rdh=1;
          end
          rdh_sum=rdh_sum + rdh * dsta
```

```
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2  % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!------- End Berm Factor Calculation, Iter: %d ---------!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
end

if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
else
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('!   Berm_width is greater than 1/4 wave length')
   disp ('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
      ddep=dep(kk+1)-dep(kk);
      dsta=sta(kk+1)-sta(kk);
      s=ddep/dsta;
      if s < 1/15
         break
      end
      fore_toe_sta=sta(kk);
      fore_toe_dep=dep(kk);
      upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
   end
   fore_Irb=upper_slope/(sqrt(fore_H0/L0));
   fore_gamma=gamma_perm*gamma_beta*gamma_rough;
   if (fore_Irb < 1.8)
      fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
   else
      fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
   end
   if berm_width >= L0
      R2_new=fore_R2
      disp ('berm is wider than one wavelength, use full shallow foreshore solution');
   else
      w2=(berm_width-0.25*L0)/(0.75*L0)
      w1=1-w2
      R2_new=w2*fore_R2 + w1*R2_new
   end
```

```
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----------------- STARTING ITERATION 1 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                20.068423
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
          9.03136363636364
R2 =
                  22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
```

```
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number:   1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
```

```
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    17
rB =
          0.199108280843155
rdh_mean =
          0.810625187975784
gamma_berm =
          0.962293906742863
slope =
          0.378674911258111
Irb =
           2.81454975146854
gamma_berm =
          0.962293906742863
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.577376344045718
ans =
!!! - - Iribaren number:   2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.5964003534129
R2del =
          0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
          0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
```

```
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number:   2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
```

```
          14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:   2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
```

```
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          23.8092710365979
diary off
-1.000000e+00
-1.000000e+00
```

PART 5: RUNUP2

for transect: CM-144-1

Station locations shifted by: -21.55 feet from their
original location to set the shoreline to
elevation 0 for RUNUP2 input

RUNUP2 INPUT CONVERSIONS
for transect: CM-144-1

Incident significant wave height: 6.94 feet

Peak wave period: 10.00 seconds

Mean wave height: 4.35 feet

Local Depth below SWEL: 24.54 feet

Mean wave height deshoaled using Hunt approximation for
celerity assuming constant wave energy flux.
References: R.G. Dean and R.A. Dalrymple. 2000. Water

Wave Mechanics for Engineers and Scientists. World
Scientific Publishing Company, River Edge New Jersy

USACE (1985), Direct Methods for Calculating Wavelength, CETN-1-17
US Army Engineer Waterways Experiment Station Coastel Engineering
Research Center, Vicksburg, MS

also see Coastal Engineering Manual Part II-3
for discussion of shoaling coefficient

Depth, D = 24.54
Period, T = 8.50
Waveheight, H = 4.35
Deep water wavelength, L0 (ft)
L0 = g*T*T/twopi
L0 = 32.17*8.50*8.50/6.28 = 369.97
Deep water wave celerity, C0 (ft/s)
C0 = L0/T
C0 = 369.97/8.50 = 43.53
Angular frequency, sigma (rad/s)
sigma = twopi/T
sigma = 6.28/8.50 = 0.74
Hunts (1979) approximation for Celerity C1H (ft/s) at Depth D (ft)
y = sigma.*sigma.*D./g
y = 0.74*0.74*24.54/32.17 = 0.42
C1H = sqrt(g.*D./(y+1./(1 + 0.6522.*y + 0.4622.*y.^2 + 0.0864.*y.^4 +0.0675.*y.^5)))
C1H = 26.15
Shoaling Coefficient KsH
KsH = sqrt(C0/C1H)
KsH = sqrt(43.53/26.15) = 1.29
Deepwater Wave Height H0_H (ft)
H0_H = H/KsH
H0_H = 4.35/1.29 = 3.37

Deepwater mean wave height: 3.37 feet

END RUNUP2 CONVERSIONS

RUNUP2 RESULTS
for transect: CM-144-1

RUNUP2 SWEL:
8.80
8.80
8.80
8.80

8.80
8.80
8.80
8.80
8.80

RUNUP2 deepwater mean wave heights:
3.20
3.20
3.20
3.37
3.37
3.37
3.54
3.54
3.54

RUNUP2 mean wave periods:
8.07
8.50
8.93
8.07
8.50
8.93
8.07
8.50
8.93

RUNUP2 runup above SWEL:
3.58
3.80
4.20
3.79
4.05
4.38
3.94
4.24
4.61

RUNUP2 Mean runup height above SWEL: 4.07 feet

RUNUP2 2-percent runup height above SWEL: 8.94 feet

RUNUP2 2-percent runup elevation: 17.74 feet-NAVD88

RUNUP2 Messages:
Nonfatal Error, Check Output

_____END RUNUP2 RESULTS_____

_____ACES BEACH RUNUP_____

Incident significant wave height: 6.94 feet

Significant wave height deshoaled using Hunt equation

Deepwater significant wave height: 4.72 feet

Peak wave period: 10.00 seconds

Average beach Slope: 1:4.96 (H:V)

ACES RUNUP CALCULATED USING 'Aces_Beach_Runup.m'

ACES Beach 2-percent runup height above SWEL: 14.86 feet

ACES Beach 2-percent runup elevation: 23.66 feet-NAVD88

!!!ACES BEACH RUNUP is NOT valid

______________END ACES BEACH RESULTS_____________________

PART 5 COMPLETE____

```
  FEMA                                                  sjh            job 2
  RUNUP2 transect: CM-144-1                                                1
7.00
  -15.74 -111.9 0.6
  -15.12 -102.9 0.6
  -14.97 -101.9 0.6
  -13.14 -92.9  0.6
  -12.13 -87.9  0.6
  -11.52 -84.9  0.6
  -10.51 -79.9  0.6
  -9.90 -76.9  0.6
  -8.89 -71.9  0.6
  -8.28 -68.9  0.6
  -7.26 -63.9  0.6
  -6.65 -60.9  0.6
  -5.64 -55.9  0.6
  -1.99 -37.9  0.6
  -0.11 -28.9  0.6
  -0.11 -1.9   0.6
  7.13  21.6   0.6
  10.53 41.6   0.6
  22.02 59.6   0.6
1 29.63 113.1  0.6
 8.8   3.20  8.07
 8.8   3.20  8.50
 8.8   3.20  8.93
 8.8   3.37  8.07
 8.8   3.37  8.50
 8.8   3.37  8.93
 8.8   3.54  8.07
 8.8   3.54  8.50
 8.8   3.54  8.93
```

****

CROSS SECTION PROFILE

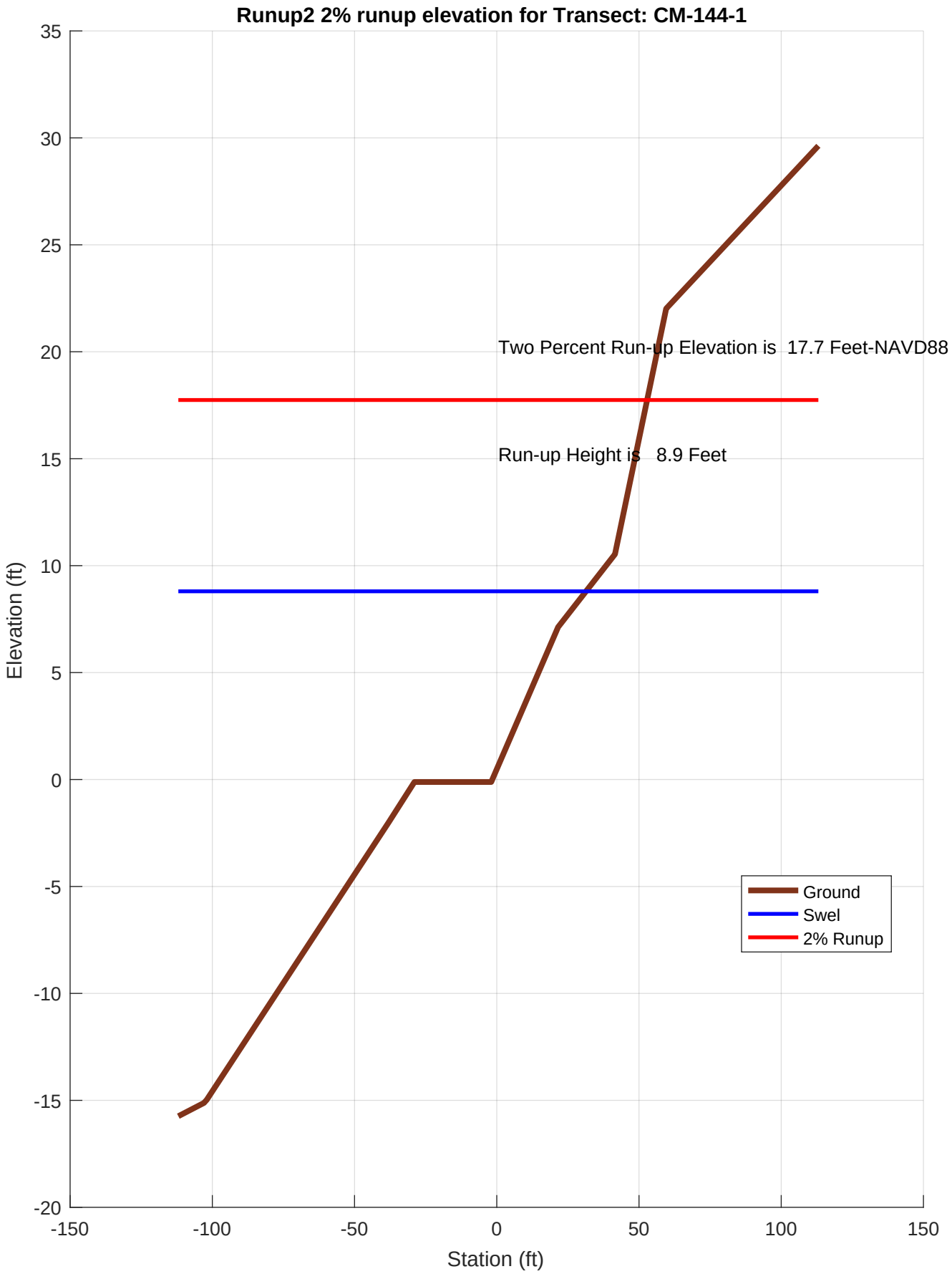
	LENGTH	ELEV.	SLOPE	ROUGHNESS
1	-111.0	-15.7		
			.00	.60
2	-102.0	-15.1		
			5.00	.60
3	-101.0	-14.9		
			4.50	.60
4	-92.9	-13.1		
			5.00	.60
5	-87.9	-12.1		
			5.00	.60
6	-84.9	-11.5		
			5.00	.60
7	-79.9	-10.5		
			5.00	.60
8	-76.9	-9.9		
			4.95	.60
9	-71.9	-8.9		
			4.92	.60
10	-68.9	-8.3		
			4.90	.60
11	-63.9	-7.3		
			4.92	.60
12	-60.9	-6.6		
			4.95	.60
13	-55.9	-5.6		
			4.93	.60
14	-37.9	-2.0		
			4.79	.60
15	-28.9	-.1		
			FLAT	.60
16	-1.9	-.1		
			3.25	.60
17	21.6	7.1		
			5.88	.60
18	41.6	10.5		
			1.57	.60
19	59.6	22.0		
			7.03	.60
20	113.1	29.6		

LAST SLOPE 7.00 LAST ROUGHNESS .60

****

OUTPUT TABLE

INPUT PARAMETERS			RUNUP RESULTS			
WATER LEVEL ABOVE DATUM (FT.)	DEEP WATER WAVE HEIGHT (FT.)	WAVE PERIOD (SEC.)	BREAKING SLOPE NUMBER	RUNUP SLOPE NUMBER	RUNUP ABOVE WATER LEVEL (FT.)	BREAKER DEPTH (FT.)
8.80	3.20	8.07	11	18	3.58	4.64
8.80	3.20	8.50	11	18	3.80	4.73
8.80	3.20	8.93	11	18	4.20	4.81
COMPOSITE SLOPE USED BUT WAVE MAY REFLECT, NOT BREAK						
8.80	3.37	8.07	11	18	3.79	4.84
8.80	3.37	8.50	11	18	4.05	4.93
8.80	3.37	8.93	11	18	4.38	5.02
8.80	3.54	8.07	11	18	3.94	5.05
8.80	3.54	8.50	11	18	4.24	5.14
8.80	3.54	8.93	11	18	4.61	5.23


Runup2 2% runup elevation for Transect: CM-144-1
Two Percent Run-up Elevation is 17.7 Feet-NAVD88
Run-up Height is 8.9 Feet
Ground
Swel
2% Runup
Elevation (ft)
Station (ft)
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-150
-100
-50
0
50
100
150