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diary on          % begin recording

% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-137
% calculation by SJH, Ransom Consulting, Inc. 20-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-137sta_ele_include.csv'; % file with station, elevation, include
                                         % third column is 0 for excluded points
imgname='logfiles/CM-137-runup';
SWEL=8.8077; % 100-yr still water level including wave setup.
H0=4.9302; % significant wave height at toe of structure
Tp=9.6953; % peak period, 1/fma,
T0=Tp/1.1;

gamma_berm=0.94202; % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;

setupAtToe=0.0016634;
maxSetup=0.73897; % only used in case of berm/shallow foreshore weighted average

plotTitle='Iterative TAW for CM-137'

plotTitle =

Iterative TAW for CM-137

% END CONFIG
%-----

SWEL=SWEL+setupAtToe

SWEL =

8.8093634

SWEL_fore=SWEL+maxSetup

SWEL_fore =

9.5483334

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

L0 =

397.501015444419

% 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

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

Ztoe =

    1.4140634

% 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 =

    16.2046634

% 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 =

    40.7079960918417

top_sta =

    137.619585407725

% 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 =

    137.619585407725

toe_sta

toe_sta =

    40.7079960918417

% 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')

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    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 59.7 ft landward of toe of slope

ans =

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

ans =

-!!-          setup is adjusted to 0.06 feet

ans =

-!!-          SWEL is adjusted to 8.87 feet

k =

    1
    2
    3
    4
    5
    6

% 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

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% 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('!!! - - Iribarren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gamma_berm)
    TAW_VALID=0;
else
    sprintf('!!! - - Iribarren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_berm)
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 berm')
end

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% 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 =
    1.4140634
toe_sta =
    40.7079960918417
top_sta =
    137.619585407725
Z2 =
    16.2046634
H0 =
    4.9302
Tp =
    9.6953
T0 =
    8.81390909090909
R2 =
    14.7906
Z2 =
    23.6580921948499
top_sta =
    196.385252903886
Lslope =
    155.677256812044
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
    5.58809219484985
rdh_sum =
    0.604038036299631
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
    5.52509219484985
rdh_sum =
    1.19823932561153
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 73

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dh =
    -4.37083280515015
rdh_sum =
    1.39867523922016
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 74
dh =
    -4.34068280515015
rdh_sum =
    1.5965536234778
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 77
dh =
    -4.55935780515015
rdh_sum =
    1.81325589487427
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 78
dh =
    -4.55905780515015
rdh_sum =
    2.02993191377365
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 79
dh =
    -4.55155780515015
rdh_sum =
    2.2459519944068
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 80
dh =
    -4.53685780515015
rdh_sum =
    2.46068852810624
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 81
dh =
    -4.52120780515015
rdh_sum =
    2.67406162129848
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 82
dh =
    -4.50460780515015
rdh_sum =
    2.88599197095693
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 83
dh =
    -4.51523280515015
rdh_sum =
    3.09884535198232
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 84
dh =
    -4.55308280515015
rdh_sum =
    3.31499874841325
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
    12
rB =
    0.0770825504363049
rdh_mean =
    0.276249895701104
gamma_berm =
    0.944211496082099
slope =
    0.154819414626972
Irb =
    1.39015195114568
gamma_berm =
    0.944211496082099
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.75536919686568
ans =
!!! - - Iribaren number: 1.31 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:6.5 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    9.16345703929551
R2del =
    5.62714296070449

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Z2 =
    18.0309492341454
ans =
!----- STARTING ITERATION 2 -----!
Ztoe =
    1.4140634
toe_sta =
    40.7079960918417
top_sta =
    147.218429306644
Z2 =
    18.0309492341454
H0 =
    4.9302
Tp =
    9.6953
T0 =
    8.81390909090909
R2 =
    9.16345703929551
Z2 =
    18.0309492341454
top_sta =
    147.218429306644
Lslope =
    106.510433214802
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
    5.58809219484985
rdh_sum =
    0.604038036299631
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
    5.52509219484985
rdh_sum =
    1.19823932561153
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 73
dh =
    -4.37083280515015
rdh_sum =
    1.66211852162778
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 74
dh =
    -4.34068280515015
rdh_sum =
    2.12084494582478
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 77
dh =
    -4.55935780515015
rdh_sum =
    2.61700954389453
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 78
dh =
    -4.55905780515015
rdh_sum =
    3.11312271765498
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 79
dh =
    -4.55155780515015
rdh_sum =
    3.6079502984605
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 80
dh =
    -4.53685780515015
rdh_sum =
    4.10025822416462
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 81
dh =
    -4.52120780515015
rdh_sum =
    4.58988387614565
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 82
dh =
    -4.50460780515015
rdh_sum =
    5.07666476078171
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 83
dh =
    -4.51523280515015

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rdh_sum =
    5.56526642437265
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 84
dh =
    -4.55308280515015
rdh_sum =
    6.06035540658532
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
    12
rB =
    0.112665019170463
rdh_mean =
    0.505029617215443
gamma_berm =
    0.944234152334766
slope =
    0.175820650365434
Irb =
    1.5787259029891
gamma_berm =
    0.944234152334766
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.755387321867813
ans =
!!! - Iribaren number: 1.49 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - slope: 1:5.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    10.4067286321687
R2del =
    1.24327159287315
Z2 =
    19.2742208270185
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
    1.4140634
toe_sta =
    40.7079960918417
top_sta =
    158.081440166173
Z2 =
    19.2742208270185
H0 =
    4.9302
Tp =
    9.6953
T0 =
    8.81390909090909
R2 =
    10.4067286321687
Z2 =
    19.2742208270185
top_sta =
    158.081440166173
Lslope =
    117.373444074331
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
    5.58809219484985
rdh_sum =
    0.604038036299631
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
    5.52509219484985
rdh_sum =
    1.19823932561153
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 73
dh =
    -4.37083280515015
rdh_sum =
    1.5738948334539
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 74
dh =
    -4.34068280515015
rdh_sum =
    1.94514767402656

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ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 77
dh =
    -4.55935780515015
rdh_sum =
    2.34855165884679
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 78
dh =
    -4.55905780515015
rdh_sum =
    2.75191121503677
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 79
dh =
    -4.55155780515015
rdh_sum =
    3.15416031402383
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 80
dh =
    -4.53685780515015
rdh_sum =
    3.55423437572973
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 81
dh =
    -4.52120780515015
rdh_sum =
    3.95199500020828
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 82
dh =
    -4.50460780515015
rdh_sum =
    4.3473042503047
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 83
dh =
    -4.51523280515015
rdh_sum =
    4.74418222871299
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 84
dh =
    -4.55308280515015
rdh_sum =
    5.14665708026423
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
    12
rB =
    0.102237776991536
rdh_mean =
    0.428888090022019
gamma_berm =
    0.941610787910461
slope =
    0.169493913612806
Irb =
    1.52191697200171
gamma_berm =
    0.941610787910461
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.753288630328369
ans =
!!! - - Iribaren number: 1.43 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:5.9 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    10.0043799329634
R2del =
    0.402348699205216
Z2 =
    18.8718721278133
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
    1.4140634
toe_sta =
    40.7079960918417
top_sta =
    154.565942575913

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Z2 =
    18.8718721278133
H0 =
    4.9302
Tp =
    9.6953
T0 =
    8.81390909090909
R2 =
    10.0043799329634
Z2 =
    18.8718721278133
top_sta =
    154.565942575913
Lslope =
    113.857946484072
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
    5.58809219484985
rdh_sum =
    0.604038036299631
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
    5.52509219484985
rdh_sum =
    1.19823932561153
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 73
dh =
    -4.37083280515015
rdh_sum =
    1.59975696570555
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 74
dh =
    -4.34068280515015
rdh_sum =
    1.99663794932747
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 77
dh =
    -4.55935780515015
rdh_sum =
    2.42733176043071
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 78
dh =
    -4.55905780515015
rdh_sum =
    2.85797892332342
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 79
dh =
    -4.55155780515015
rdh_sum =
    3.28746008206554
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 80
dh =
    -4.53685780515015
rdh_sum =
    3.71465701332937
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 81
dh =
    -4.52120780515015
rdh_sum =
    4.13942380306943
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 82
dh =
    -4.50460780515015
rdh_sum =
    4.56161492180336
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 83
dh =
    -4.51523280515015
rdh_sum =
    4.98545438600081
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 84
dh =
    -4.55308280515015
rdh_sum =
    5.41517260078245
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!

```

```

berm_width =
  12
rB =
  0.105394488224665
rdh_mean =
  0.451264383398538
gamma_berm =
  0.942166290517643
slope =
  0.171393684345907
Irb =
  1.53897536224117
gamma_berm =
  0.942166290517643
gamma_perm =
  1
gamma_beta =
  1
gamma_rough =
  0.8
gamma =
  0.753733032414114
ans =
!!! - - Iribaren number: 1.45 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:5.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
  10.1224821494486
R2del =
  0.118102216485209
Z2 =
  18.9899743442985
ans =
!----- STARTING ITERATION 5 -----!
Ztoe =
  1.4140634
toe_sta =
  40.7079960918417
top_sta =
  155.597853598064
Z2 =
  18.9899743442985
H0 =
  4.9302
Tp =
  9.6953
T0 =
  8.81390909090909
R2 =
  10.1224821494486
Z2 =
  18.9899743442985
top_sta =
  155.597853598064
Lslope =
  114.889857506223
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 15
dh =
  5.58809219484985
rdh_sum =
  0.604038036299631
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 16
dh =
  5.52509219484985
rdh_sum =
  1.19823932561153
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 73
dh =
  -4.37083280515015
rdh_sum =
  1.59191987625591
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 74
dh =
  -4.34068280515015
rdh_sum =
  1.98103350282899
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 77
dh =
  -4.55935780515015
rdh_sum =
  2.40346573417151
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 78
dh =
  -4.55905780515015

```

```

rdh_sum =
    2.82585197581539
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 79
dh =
    -4.55155780515015
rdh_sum =
    3.24708869470019
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 80
dh =
    -4.53685780515015
rdh_sum =
    3.66607359266593
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 81
dh =
    -4.52120780515015
rdh_sum =
    4.08266299822666
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 82
dh =
    -4.50460780515015
rdh_sum =
    4.49671364992218
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 83
dh =
    -4.51523280515015
rdh_sum =
    4.91238899848386
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 84
dh =
    -4.55308280515015
rdh_sum =
    5.33385941930112
ans =
!----- End Berm Factor Calculation, Iter: 5 -----!
berm_width =
    12
rB =
    0.104447862156588
rdh_mean =
    0.44448828494176
gamma_berm =
    0.941977988959227
slope =
    0.170822580284315
Irb =
    1.5338473140087
gamma_berm =
    0.941977988959227
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.753582391167382
ans =
!!! - - Iribaren number: 1.44 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:5.9 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    10.0867364993734
R2del =
    0.0357456500752331
Z2 =
    18.9542286942233
ans =
!----- STARTING ITERATION 6 -----!
Ztoe =
    1.4140634
toe_sta =
    40.7079960918417
top_sta =
    155.28552812777
Z2 =
    18.9542286942233
H0 =
    4.9302
Tp =
    9.6953
T0 =
    8.81390909090909
R2 =
    10.0867364993734

```

```

Z2 =
    18.9542286942233
top_sta =
    155.28552812777
Lslope =
    114.577532035928
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 15
dh =
    5.58809219484985
rdh_sum =
    0.604038036299631
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 16
dh =
    5.52509219484985
rdh_sum =
    1.19823932561153
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 73
dh =
    -4.37083280515015
rdh_sum =
    1.59426976536326
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 74
dh =
    -4.34068280515015
rdh_sum =
    1.98571226365423
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 77
dh =
    -4.55935780515015
rdh_sum =
    2.41062241812904
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 78
dh =
    -4.55905780515015
rdh_sum =
    2.83548638415188
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 79
dh =
    -4.55155780515015
rdh_sum =
    3.25919585311649
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 80
dh =
    -4.53685780515015
rdh_sum =
    3.6806437212517
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 81
dh =
    -4.52120780515015
rdh_sum =
    4.0996856414664
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 82
dh =
    -4.50460780515015
rdh_sum =
    4.51617766922246
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 83
dh =
    -4.51523280515015
rdh_sum =
    4.93430152891594
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 84
dh =
    -4.55308280515015
rdh_sum =
    5.35824571210359
ans =
!----- End Berm Factor Calculation, Iter: 6 -----!
berm_width =
    12
rB =
    0.104732575285678
rdh_mean =
    0.446520476008633
gamma_berm =
    0.942032664084493
slope =
    0.17099422208832

```

```

Irb =
1.53538851728292
gamma_berm =
0.942032664084493
gamma_perm =
1
gamma_beta =
1
gamma_rough =
0.8
gamma =
0.753626131267594
ans =
!!! - - Iribaren number: 1.45 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:5.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
10.0974576610312
R2del =
0.0107211616577576
Z2 =
18.964949855881
ans =
!----- STARTING ITERATION 7 -----!
Ztoe =
1.4140634
toe_sta =
40.7079960918417
top_sta =
155.379203633735
Z2 =
18.964949855881
H0 =
4.9302
Tp =
9.6953
T0 =
8.81390909090909
R2 =
10.0974576610312
Z2 =
18.964949855881
top_sta =
155.379203633735
Lslope =
114.671207541894
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 15
dh =
5.58809219484985
rdh_sum =
0.604038036299631
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 16
dh =
5.52509219484985
rdh_sum =
1.19823932561153
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 73
dh =
-4.37083280515015
rdh_sum =
1.59356296338389
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 74
dh =
-4.34068280515015
rdh_sum =
1.98430497158032
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 77
dh =
-4.55935780515015
rdh_sum =
2.4084698814978
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 78
dh =
-4.55905780515015
rdh_sum =
2.83258866262759
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 79
dh =
-4.55155780515015
rdh_sum =
3.25555443996
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 80

```

```

dh =
    -4.53685780515015
rdh_sum =
    3.67626155241782
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 81
dh =
    -4.52120780515015
rdh_sum =
    4.09456585583299
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 82
dh =
    -4.50460780515015
rdh_sum =
    4.51032361085259
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 83
dh =
    -4.51523280515015
rdh_sum =
    4.92771105568266
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 84
dh =
    -4.55308280515015
rdh_sum =
    5.35091124335129
ans =
!----- End Berm Factor Calculation, Iter: 7 -----!
berm_width =
    12
rB =
    0.104647018700104
rdh_mean =
    0.445909270279274
gamma_berm =
    0.942016057045361
slope =
    0.17094263207842
Irb =
    1.53492528111131
gamma_berm =
    0.942016057045361
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.753612845636289
ans =
!!! - - Iribaren number: 1.45 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:5.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    10.0942332420792
R2del =
    0.00322441895198722
Z2 =
    18.961725436929
% final 2% runoff elevation
Z2=R2_new+SWEL
Z2 =
    18.961725436929
diary off
-1.000000e+00
-1.000000e+00

```