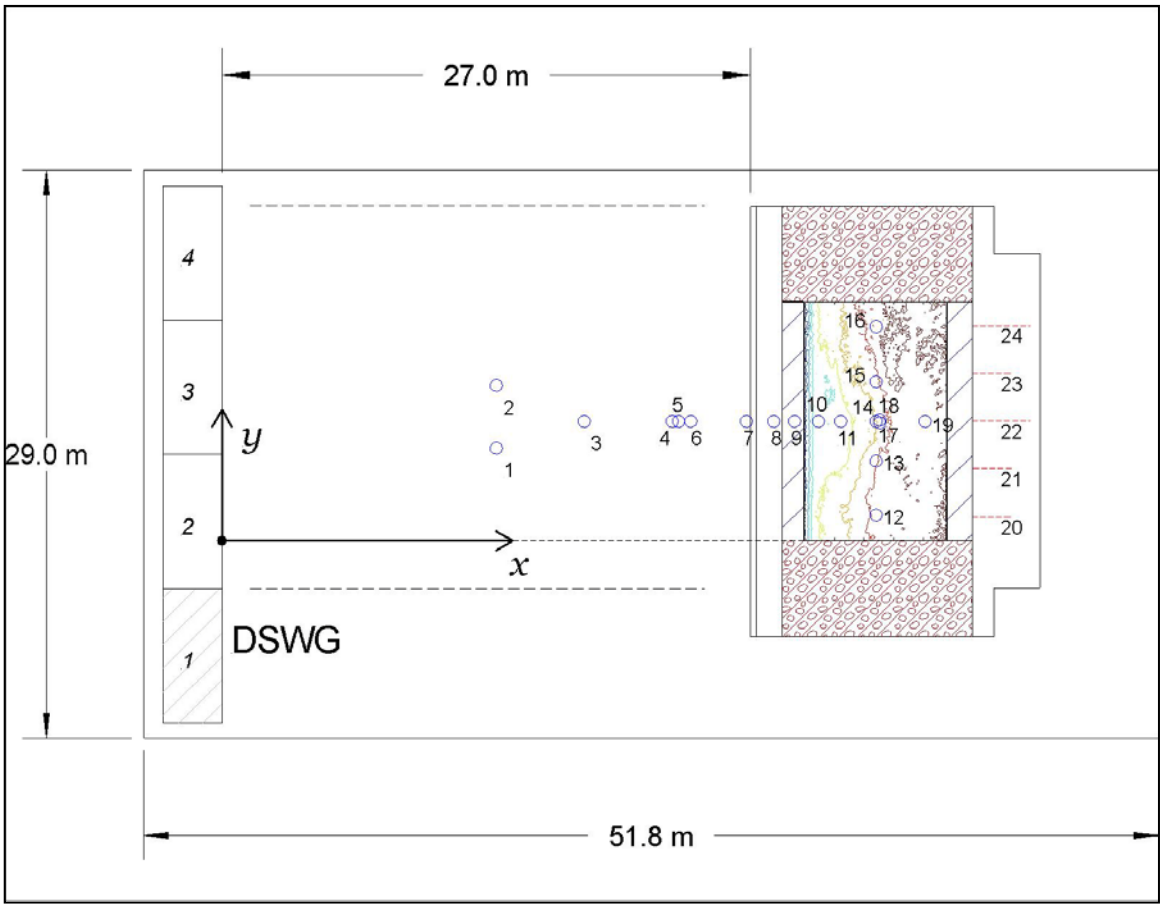
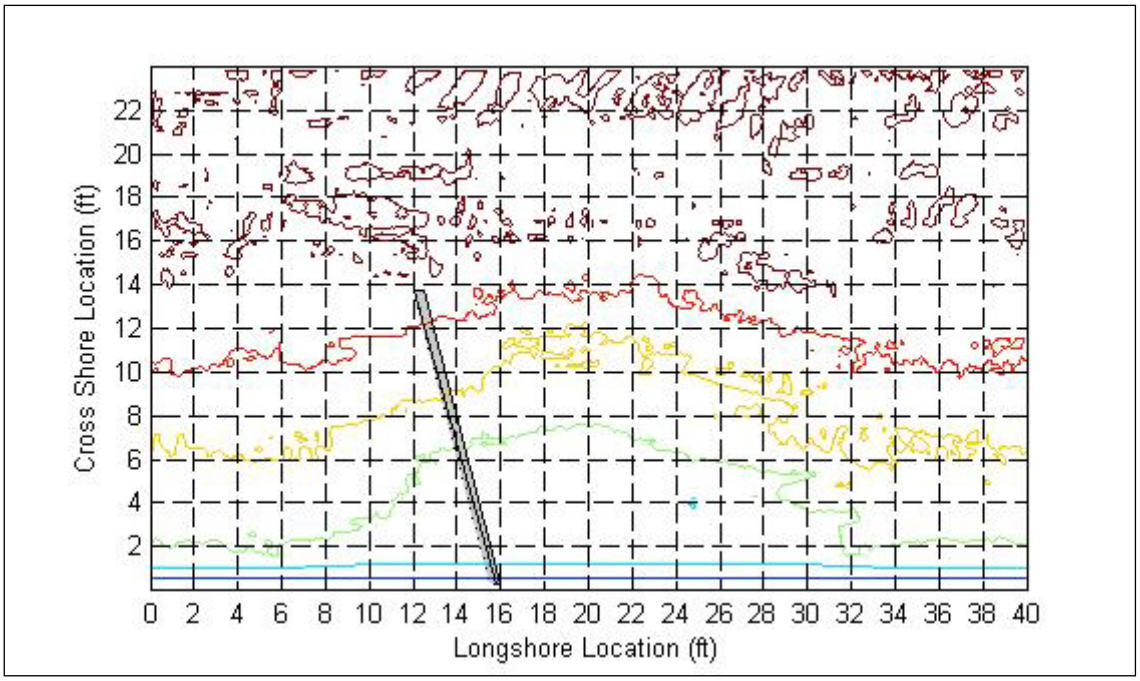
OVERVIEW OF THREE-DIMENSIONAL REEF EXPERIMENTS

The SWIMS 3D Reef Experiments are conducted in a 51.8-long by 29.0-m wide basin at 1:50 model to prototype scale, shown in the figure below and in "**DSWG_basin_layout.JPG**".



The primary goal of the experiments was to collect wave and runup data over a range wave heights and periods, water levels, and reef roughnesses. Following completion of the primary objective, a channel was cut into the bathymetry (shown below) and wave, runup, and current data was collected for selected test conditions. The following paragraphs describe the test conditions, bottom bathymetry, and data collected.



Test Conditions

Forty design (target) wave conditions were generated for each slope, which are shown in the following table and in file "**Design_Waves_3D_table.doc**". The values in the table are given in prototype units with the corresponding model units given in parenthesis. However, all results are given in model meters. The design conditions include three water levels; 0.493 m (high), 0.442 m (mid), and 0.418 m (low).

SWIMS 3D Reef
Design Wave Conditions in Prototype m (Model, m)

	h=20.9 m (0.418 m)	*h*=22.1 m (0.442 m)	*h*=24.6 m (0.493 m)
T_p sec	H_i m (m)	H_i m (m)	H_i m (m)
7 (0.99)	4.1 (0.08)	4.2 (0.08)	4.0 (0.08)
7 (0.99)	4.8 (0.10)	5.0 (0.10)	5.1 (0.10)
10 (1.41)	-	-	4.7 (0.09)
10 (1.41)	4.1 (0.08)	3.5 (0.07)	6.4 (0.13)
10 (1.41)	5.6 (0.11)	5.9 (0.12)	7.3 (0.15)
10 (1.41)	-	7.0 (0.14)	7.9 (0.16)
13 (1.84)	5.7 (0.11)	4.6 (0.09)	4.8 (0.10)
13 (1.84)	6.9 (0.14)	8.0 (0.16)	7.8 (0.16)
13 (1.84)	7.7 (0.15)	-	8.5 (0.17)
16 (2.26)	5.5 (0.11)	5.6 (0.11)	4.7 (0.09)
16 (2.26)	6.9 (0.14)	7.4 (0.15)	7.6 (0.15)
16 (2.26)	7.3 (0.15)	7.9 (0.16)	8.7 (0.17)
20 (2.83)	5.1 (0.10)	4.3 (0.09)	4.4 (0.09)
20 (2.83)	6.7 (0.13)	6.3 (0.13)	7.5 (0.15)
20 (2.83)	6.9 (0.14)	-	8.5 (0.17)
Values in parenthesis refer to values in model seconds and meters			

Nineteen wave gauges and five runup gauges (listed as Gauges 20 through 24) were installed during the tests. Wave gauge locations, given as x and y distances in meters from the wave maker and the lower edge of the acrylic bathymetry, respectively, are shown in the following table.

SWIMS 3D Reef Wave Gauge Locations

Gauge	x (m)	y (m)
1	14.02	4.73
2	14.02	7.93
3	18.50	6.10
4	22.98	6.10
5	23.32	6.10
6	23.93	6.10
7	26.79	6.10
8	28.19	6.10
9	29.23	6.10
10	30.45	6.10
11	31.61	6.10
12	33.40	1.32
13	33.40	4.06
14	33.40	6.10
15	33.40	8.13
16	33.40	10.94
17	33.58	6.03
18	33.58	6.16
19	35.91	6.10
20 (Runup)	38.44	1.23
21 (Runup)	38.44	3.67
22 (Runup)	38.44	6.10
23 (Runup)	38.44	8.55
24 (Runup)	38.44	10.98

Bathymetry

The basin contained a 14.8-m-long by 22.0-m-wide compound-slope steel platform on which the reef bathymetry was installed. The platform was configured into a compound slope that included reef slopes of 1:4 (0.29-m long) and 1:13 (2.43-m long), a 7.3 m horizontal flat section, and a 1:10 foreshore slope (4.8-m long). The reef consists of a 7.31-m long reef section constructed of molded acrylic to represent reef bathymetry and a 1:10 nearshore slope. Bathymetry of the reef and basin is given in "**SWIMS3d_bath_d.dat**", which includes xyz coordinates in model dimensions in meters. The origin of the bathymetry is at the wave maker aligned with the "lower" edge of the acrylic reef, with x positive in the onshore direction and y positive alongshore across the reef width. The reference depth in the files represents the depth at the mid-water level.

Results

A total of 78 runs were made, which include 40 runs on the unpainted, or smooth, reef surface and 38 on the painted, or roughened, reef surface. A description of each run

is given in the spreadsheet "**Basin_Log_mm.xls**". Several of the runs were repeated and runs highlighted in gray in the spreadsheet are not presented in the data summary. Data were collected at 20 Hz for 20 minutes.

Wave upcrossing, spectral and wave reflection analysis were performed for each test. The analysis summary files for each run have been placed in zip files categorized by surface roughness and water level. The naming convention of the files refers the target prototype wave condition. For example, the summary file "**RT10H20dmid_181_sum.dat**" refers a 10 sec period and 20 ft incident wave height, prototype values, at the mid water level, Run 181. The prefix "R" refers to the roughened surface; no prefix is given to the smooth surface files. A plot of wave height and mean water level as a function of distance along the centerline of the model for each wave condition also is included in the zip files.

Time series of each run is presented in ascii format in a separate zip file categorized by slope and water level and using the same naming convention with "a" replacing "sum": "**RT10H20dmid_181_a.dat**". Each file contains 25 columns; Column 1 consists of the time step of each measurement, Columns 2 through 20 contain water surface measurements from the wave gauges, and Columns 21 through 25 includes water surface elevations from the runup gauge. The runup gauge measurements were converted from distance along the 1 on 10 foreshore slope to elevation with respect to the swl. All the runup gauges were not functioning during every test; therefore, a value of -999.00 was placed in the columns of the non-functioning runup gauges.

The still water level for the low-water experiments was below the elevations of several wave gauges and the runup gauges, i.e., the gauges were out of the water at the onset of the test. Mean water levels recorded for these gauges were adjusted by adding the elevation difference between the particular gauge and the still water elevation. In tests where these gauges didn't record measurements or recorded a negative mean, the mwl was listed as -999.00. Additionally, negative values in the time series of these gauges were replaced with -999.00. The gauges above the low swl, their elevations, and the correction applied to the raw data are listed in the following table.

Elevation and mwl correction for low water level (swl = 0.418 m)

Gauge	Elevation (m)	Correction (m)
12	0.4303	+0.0123
13	0.4226	+0.0046
15	0.4220	+0.0040
16	0.4296	+0.0116
19	0.4353	+0.0173
20 through 24 (runup)	0.4420	+0.0240

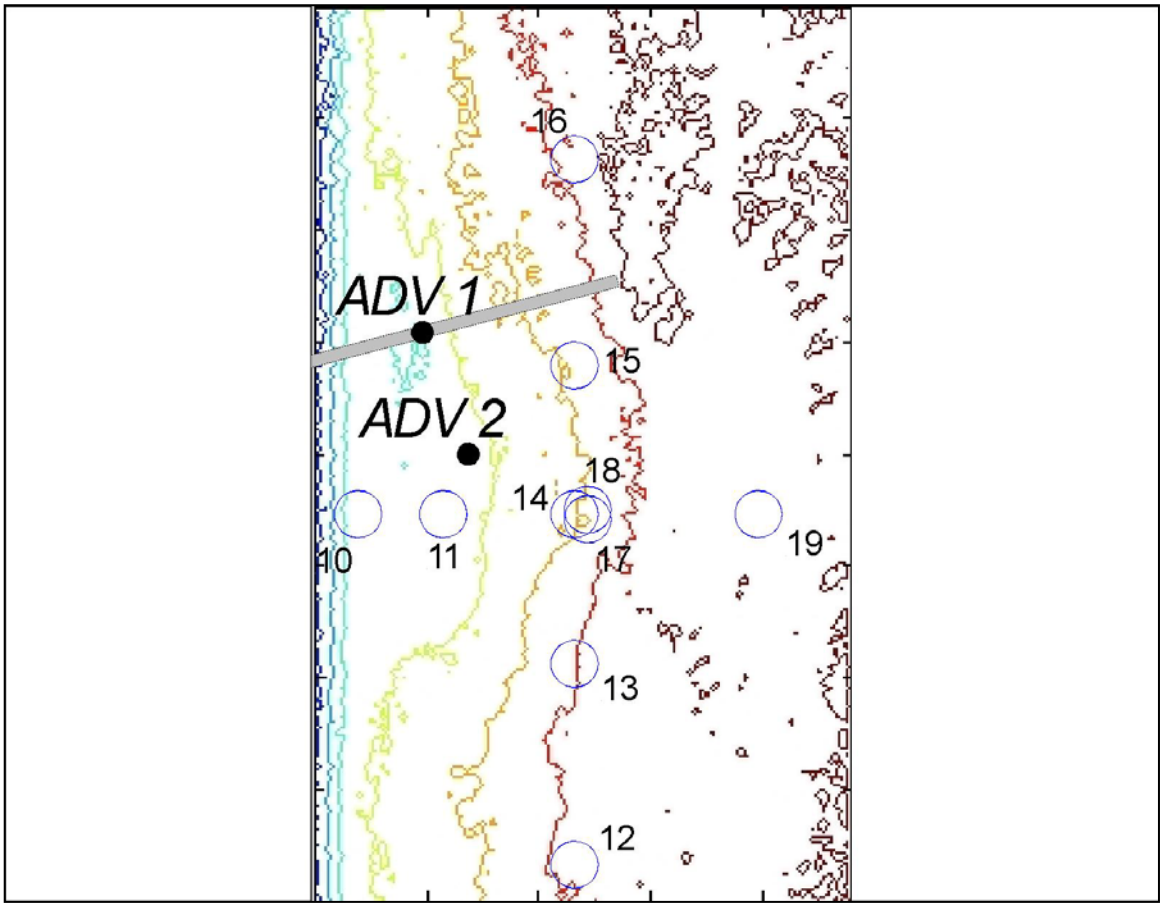
Channel Experiment:

A channel was cut into the bathymetry at an angle to incident waves following the tests on the smooth and rough surfaces. The channel was 5.5 m long and 0.15 m wide with

vertical sides that extended to the underlying steel platform (0.1-m deep with respect to the mid-water level). The shoreward end of the channel contained a 1:1 slope which transitioned to the reef surface.

Wave and velocity measurements were taken for selected wave conditions at the mid- and high water levels. Time series and summary files of the wave data are named with the same convention as the non-channel files, but are prefixed by "C". The files are located in zip files categorized by water level.

Current measurements were sampled at 20 Hz separately from the wave measurements with two acoustic Doppler velocimeters (ADVs) placed on the reef. ADV 1 was placed in the midpoint of the channel with its sampling volume measuring the center of the channel, and ADV 2 was placed near the center of the reef, shown as solid circles in the figure below. The open circles indicated wave gauge locations placed on the reef. The coordinates of the ADVs are given in the following table.



SWIMS 3D Reef ADV Locations

ADV	x (m)	y (m)
1	31.24	7.73
2	31.85	6.10

The ADVs were oriented with positive *x* onshore and positive *y* towards the top of the figure. ADV 1 was oriented with the x axis in line with the channel. The channel was oriented at 14.71 deg from the shoreline; therefore, to convert directions obtained at ADV 1 to shore normal, 14.71 deg must be subtracted from the measured direction.

Mean, minimum, maximum, and standard deviation of the measured velocities of the ADVs were calculated and presented in a summary file. Summary files were named similar to the wave files, but include "adv" to differentiate them from the wave files: "CT07H35dhi_218_adv_sum.dat".

Time series of the currents also are presented and placed in zip files, and named with an "a" in place of "sum" to denote ascii time series. Each time series files includes five columns; the first is the time step, followed by ADV-1 x velocity, ADV-1 y velocity, ADV-2 x velocity, and ADV-2 y velocity.

An attempt was made to start the current measurements simultaneously with the wave measurements; however, it is important to note that wave and current measurements are not synchronized. Additionally, the ADV measurements were collected on separate ports on the same computer and are not necessarily synchronized with each other. ADV data was collected for 20 minutes and stopped at approximately the same time as the wave measurements. Consequently, the ADV time series vary slightly in length from the wave time series.