RESULTS OF A 3-YEAR BEACH EROSION CONTROL PROJECT IN HILLSBORO BEACH, FLORIDA, UTILIZING PRESSURE EQUALIZING MODULES (PEM)

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INTRODUCTION

Pressure Equalizing Modules (PEM) is a patented passive dewatering technology that improves beach drainage. Where applicable PEM will reduce or eliminate the need for traditional beach nourishment. PEM has been used internationally for over a decade by several large contractors; however Hillsboro Beach was the first US project, and for the contractor to be paid the PEM area had to outperform the control areas by >25%.

TECHNOLOGY

PEM's are hollow permeable tubes inserted vertically into a beach in a grid from the dune to the mean low waterline. The tubes are placed one to three feet under the beach surface making the installation invisible to the naked eye. The exact grid design depends on the local conditions. The tubes are not connected and no energy is used to operate the system. The tubes penetrate and connect the different strata of the beach allowing the water to find the easiest way out via gravity during falling (outgoing) tide, typically via a coarser layer, resulting in improved drainage (see Figure 1).

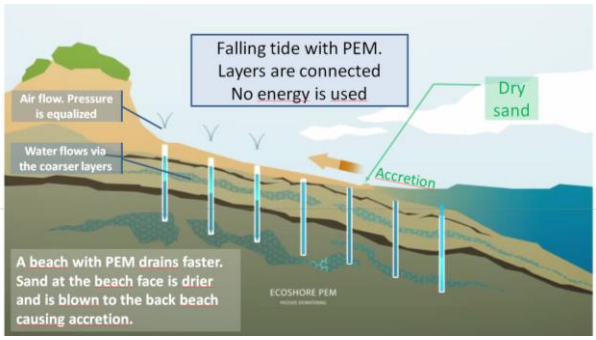

Figure 1 – Working mechanism of the PEM system

A connection to the atmosphere through a vent at the top of the tube allows pressure to be equalized, hence the name PEM - pressure equalizing modules. As a result, the time period where the beach is saturated and prone to erosion is reduced. With improved drainage more sand is deposited in the swash zone and via aeolian transport moved to the back beach and dunes resulting in reduced erosion and - more often – accretion.

During storms a PEM area is proven to lose less sand and buildup faster. PEMs cause no down-drift erosion (see Figure 3), no escarpments and have a proven turtle friendly design. The carbon footprint is minimal as they require no pumping to operate.

LOCATION

Hillsboro Beach is located in Broward county 25 miles North of Miami, Florida on the Atlantic Coast with predominant southward littoral drift. The town covers 3.2 miles of beach and stretches from Deerfield Beach in the North to Hillsboro Inlet in South. The northern 1-mile section from R7 to 12 is defined as Critically Eroding and was the location where the PEM system was installed in 2008. Avg. sand loss from 2001-7 in the PEM project area (R7-12) was -3.9 cubic yards per shore foot from R-monument line to depth of closure (DOC), whereas the ½ mile controls South and North gained 1.2 to 1.9 cy/ft.

The predominant winds affecting the beach are from Northeast, tides are semidiurnal with a typical range of 2-3 ft. Groins at Deerfield Beach are likely to cause movement of sand offshore contributing to erosion at R7. Other factors affecting erosion could be fine layers of silt or clay slowing down beach drainage, a problem PEM is designed to solve.

During the project period no hurricanes affected the area. During the second 12 month period of operation no major storms or nourishments took place (see Figure 2).

PROJECT

A PEM pilot study can show if a particular beach will be positively influenced by an installation of PEM. Such a groundwater study was conducted prior to the project and it showed increased drainage when PEMs were inserted.

The installation of 90 PEMs was completed in less than 2 weeks in Feb 2008 using truck sized equipment, with no beach downtime. Due to a very thin layer of sand a large part of the PEMs had to be reduced in size. Two small truck hauls of sand were placed early in the project at R7 and in the North control area and these volumes have been deducted from any figures given below.

In Jan 2011 the PEMs were removed by the same certified FL surveyor that was responsible for PEM installation as well as all monitoring during the 3-year project in accordance with Florida DEP requirements.

RESULTS

After 18 months the PEM project area had met the success criteria as documented by the towns consulting engineer resulting in payment of the contractor and signing of a document confirming the successful result.

Monitoring continued until the PEMs had to be removed prior to beach nourishment taking place in spring 2011.

During the second year the weather was stable and no nourishments took place, making it an ideal observation period. Below in Figure 2 are the data from the 2nd full year 3/2009 – 2/2010. The historic values (2001-7) are in circles. As can be seen the North and South control fall within the norm. Only the PEM project area is performing different from Historic. The PEM project area was supposed to lose sand but gained sand.

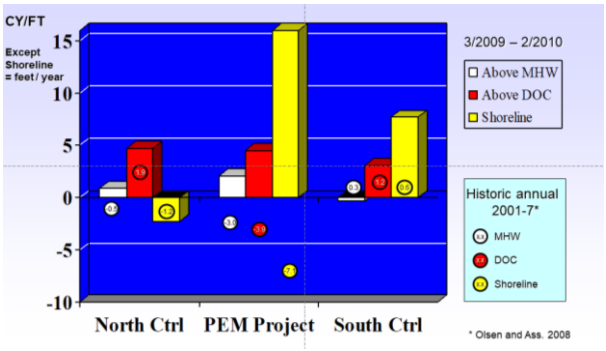

Figure 2 – Second full year. No nourishments. No storms

Elevation of the beach at the location of each PEM was recorded at the time of PEM installation and at the time of PEM removal by the same certified surveyor. Changes in beach elevation over the 3-year period can be seen in Table 1.

Beach Elevation At Removed PEMs (ft)			
	Installation	**Removal**	**Change**
Row A (MLW)	-2.26	-0.08	2.18
Row B	0.21	1.83	1.62
Row C	4.46	4.25	-0.21
Row D (Dune)	4.80	5.45	0.65

Table 1 – Elevation of beach at PEM location

From R monument line to Depth of Closure (-16.57ft) the 1-mile project area used to lose 21,000 cubic yards per year or -63,000 cy during the project period. Over the 3 year period the 1-mile PEM project area gained 47,000 cy of which 8,500 cy could be attributed to nourishment and shall be deducted. The net gain was 38,500 cy.

The DOC volume change during the 3-year period can be seen in Figure 3. The PEM project area is gaining sand instead of historically losing sand. The North and South control lie within the norm. The predominant littoral drift is from North to South and if PEM had caused any negative downdrift effect the South control would be affected. However, the South control performed slightly better than Historic documenting that PEM cause no negative downdrift effect.

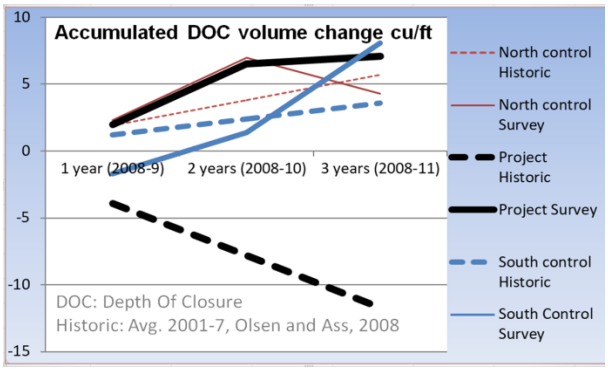

Figure 3 – Accumulated DOC volume change

At the end of the 3-year period the erosion in the PEM project area had stopped and the beach had gained sand from R monument line to MHW, to -5ft, and to DOC. Shoreline in the project area that historically lost 25 ft. in 3 years gained 26 ft. The North and South control areas were not negatively affected. Photos in Figure 4 and 5 were shot at low tide from R6.5 at project start and end.

Figure 4

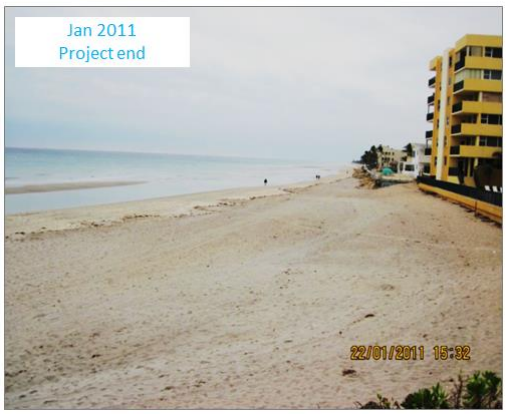

Figure 5

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Turner and Leatherman (1997): Beach dewatering as a "soft" engineering solution to coastal erosion - a history and critical review, JCR 13(4), pp. 1050-1063. Olsen and Ass, Inc.,(2008): Broward County Shore Prot. Proj - Segm. III. 1 year post const., Hillsboro Beach/Deerfield Beach, Phys.Mon.Anal.Rep. Jan. 2008