



# Bellows Air Force Station Beach Nourishment



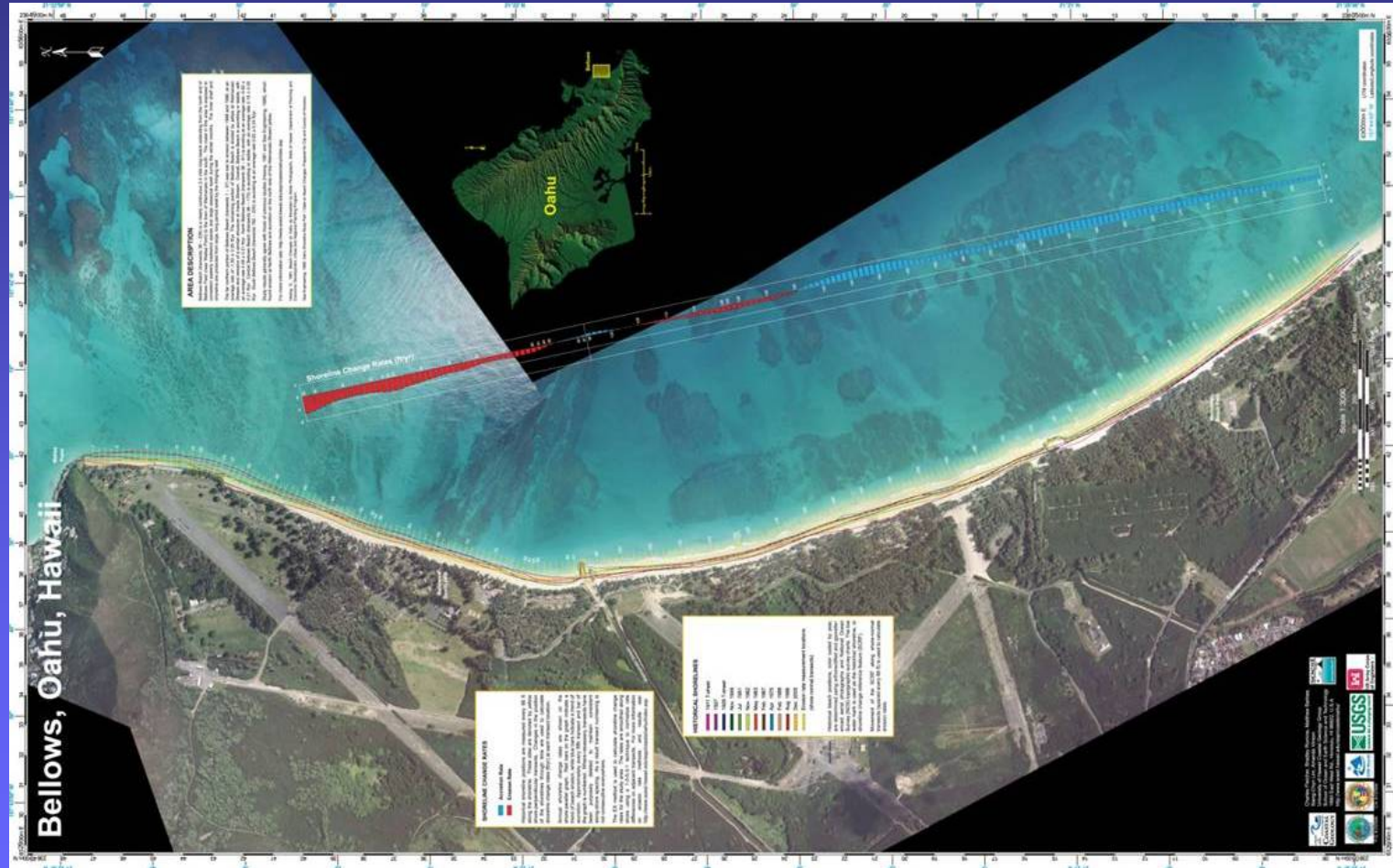
**August 27, 2008**

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Bellows Beach Nourishment



# Bellows AFS Shoreline Change Rates



**\*\* Red = Erosion Rates, Blue = Accretion Rates**

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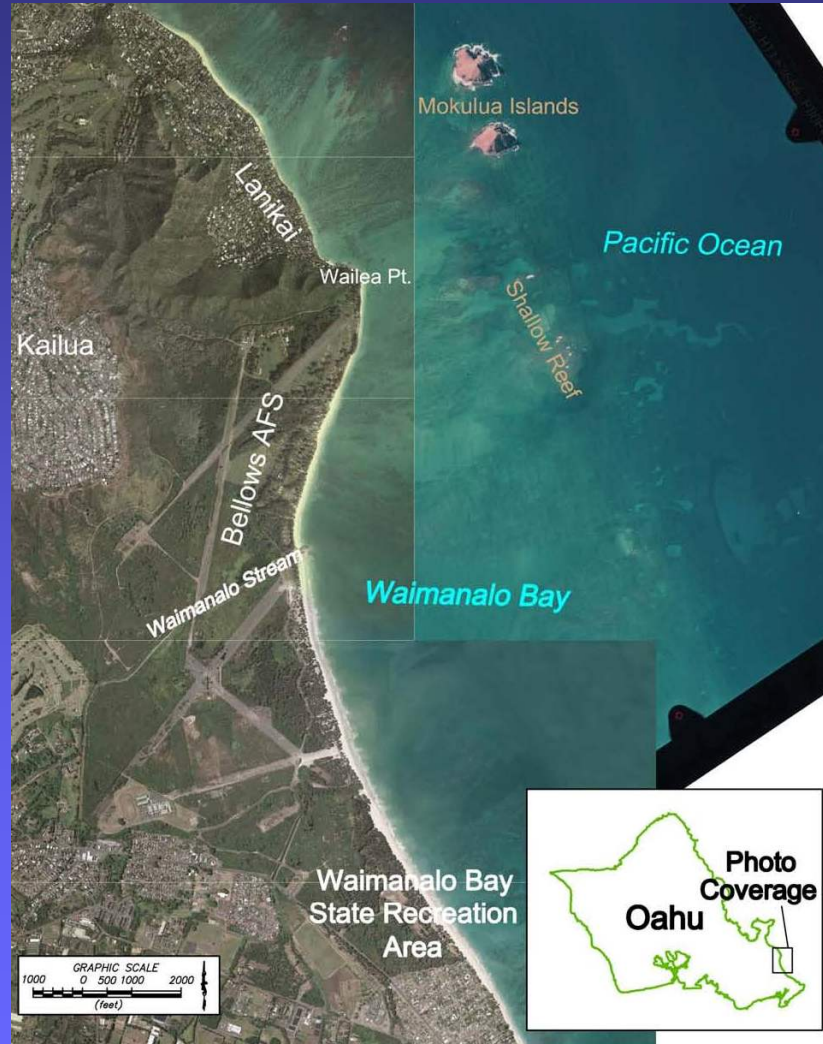
# ***Purpose of Study***



- **Nourishment of Bellows Beach to offset sand deficit incurred by construction of revetments**
- **Protect upland development and improve sections of eroded beach**
- **Increase recreational use of coastline**
- **Alternatives include beach nourishment and removal of revetments**
- **Study findings include quantification of sand volume needed, sand source identification, and quantities of sand available offshore**



# Study Vicinity





# Study Location





# Revetment Location





# *Existing Conditions*



- **Revetments**
- **Exposed Tree Roots**
- **Miscellaneous Debris**
- **Rock Retaining Walls**
- **Variable Beach Widths**





# Existing Conditions



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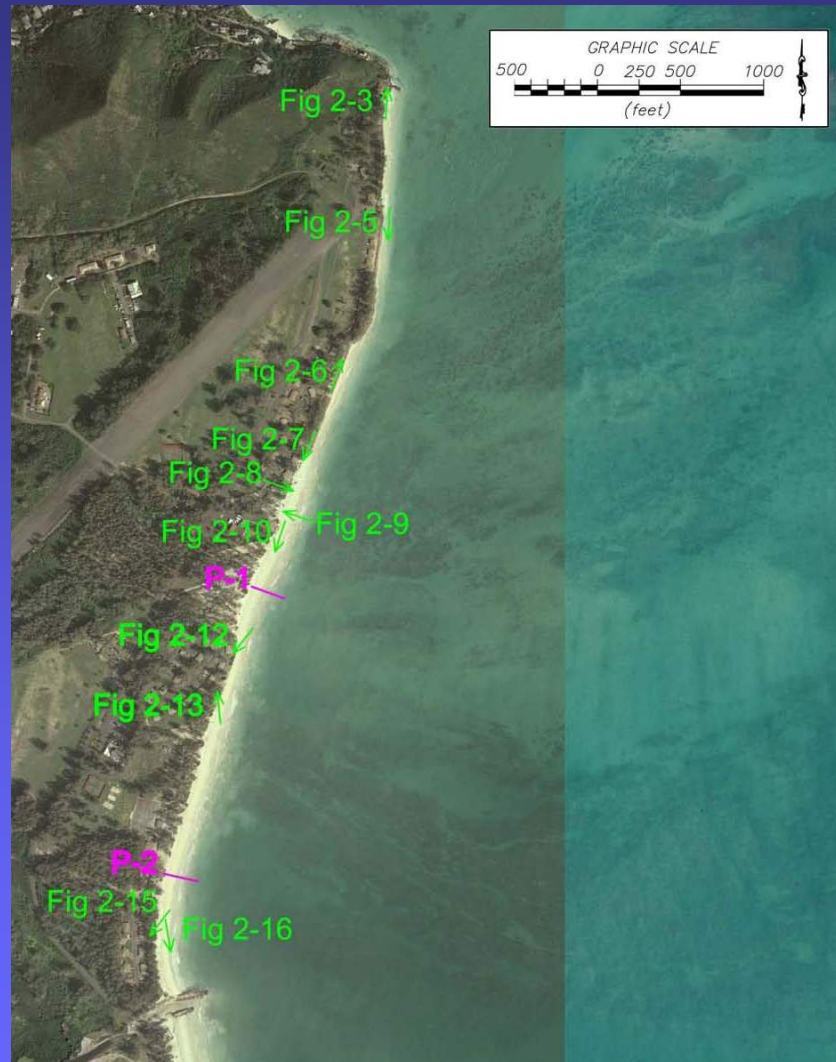


# Existing Conditions





# Beach Profile Locations

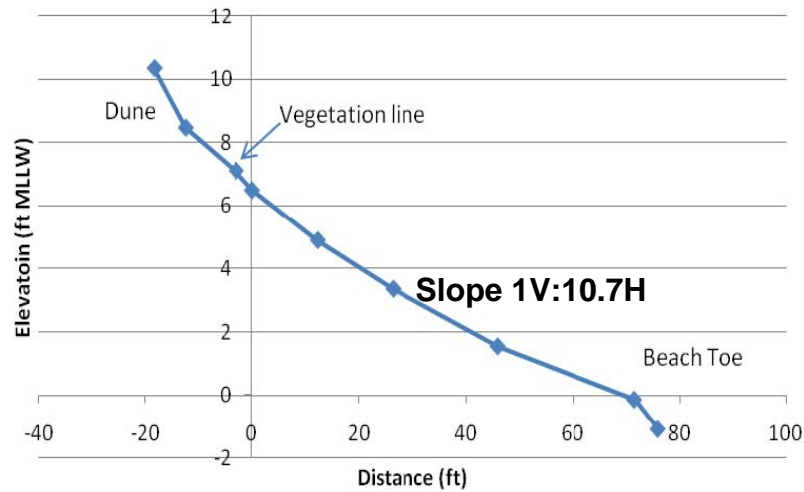




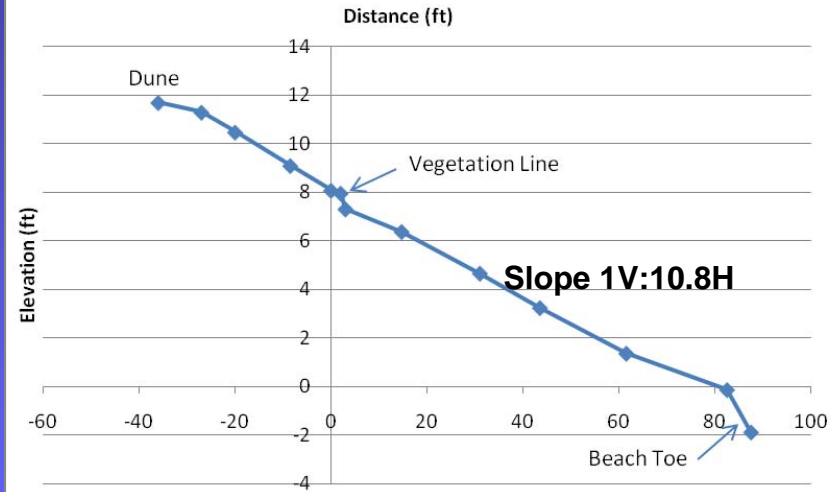
# Beach Profiles



### Bellows Profile P-1



### Bellows Profile P-2



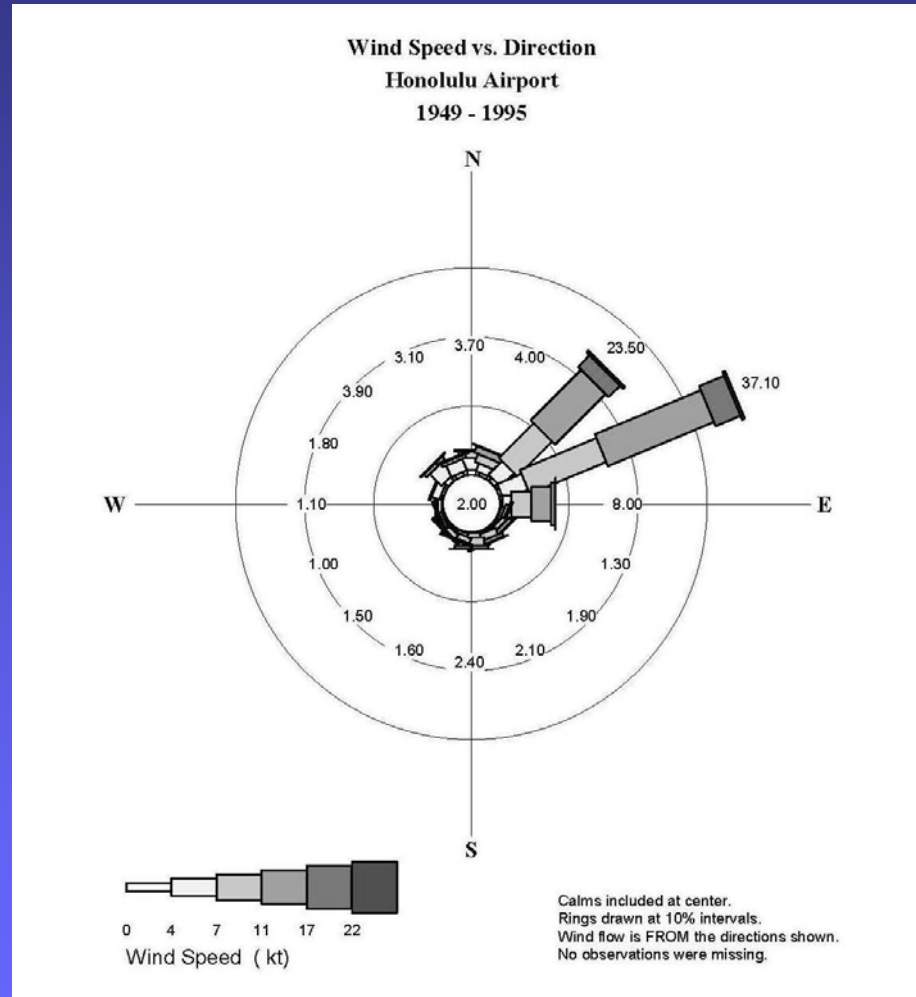


# ***Wind & Waves***



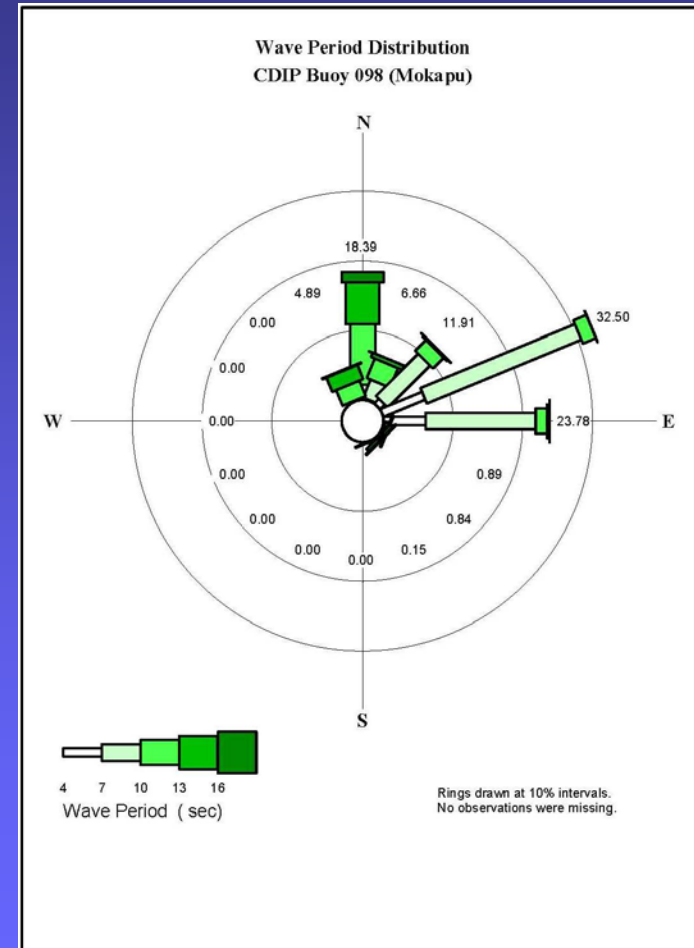
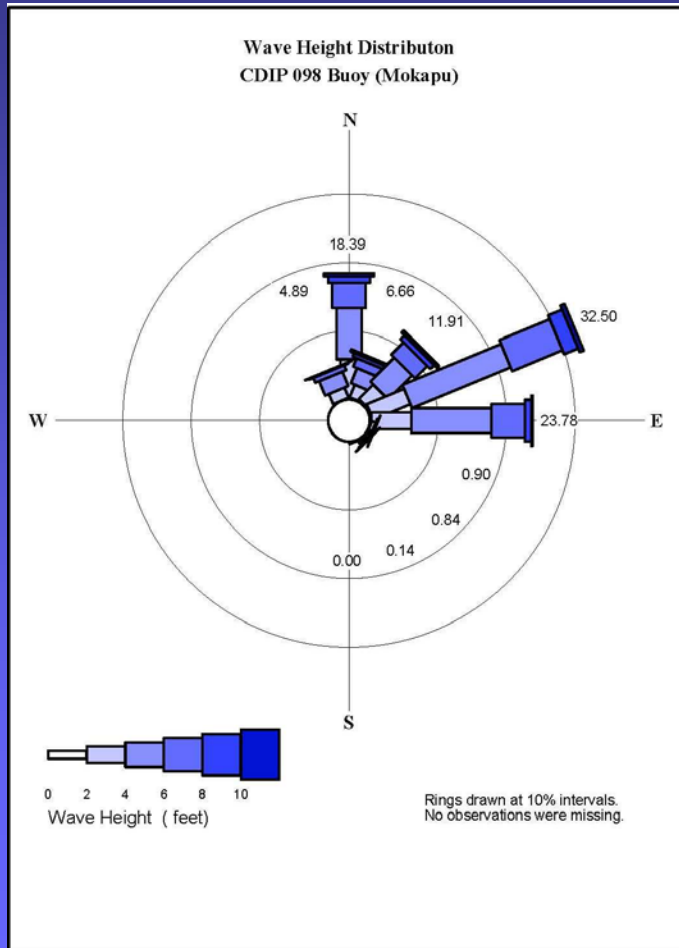
# Wind Speed & Direction

Wind Rose Diagram for Honolulu International Airport, 1949-1995





# Wave Distribution – CDIP Bouy 098 (Mokapu)





# *Wave Climate*



- **Directional distribution of wave heights and wave periods determined from UH's Mokapu buoy data**
- **Waves are predominantly out of the east through northeast**
- **North swells impact the study area**



# *Wave Modeling*

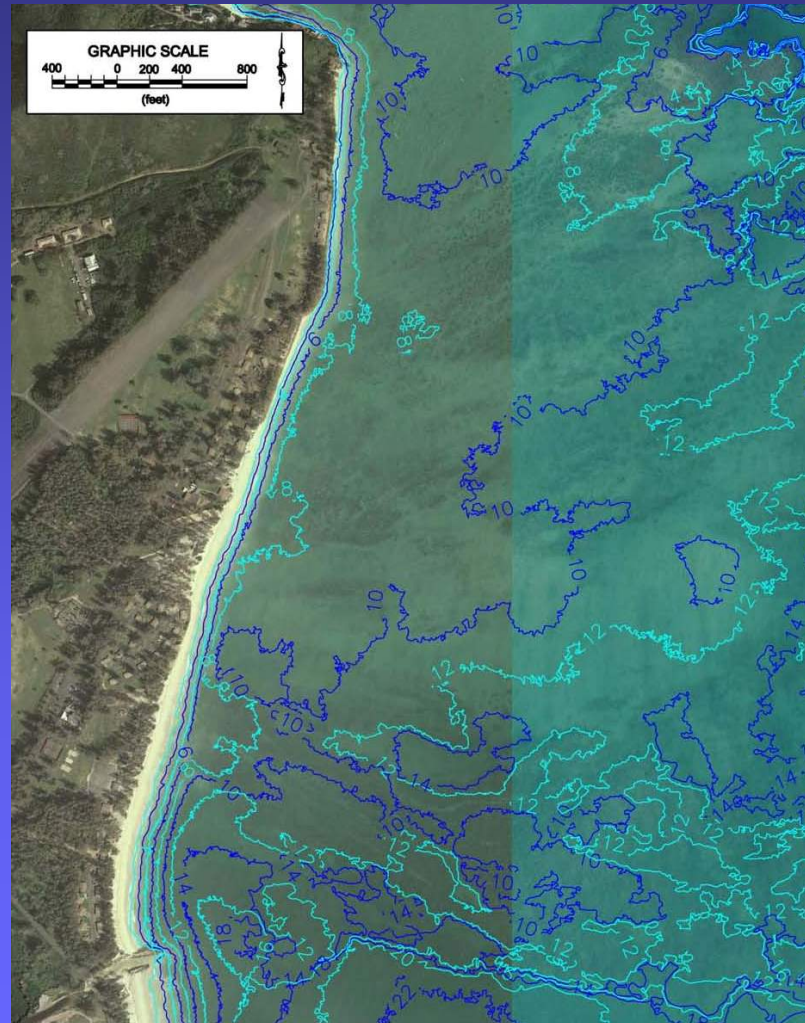


- **Input Wave Conditions:**
  - $D = 0$  degrees,  $T = 14$  seconds,  $H = 6$  feet
  - $D = 45$  degrees,  $T = 8$  seconds,  $H = 6$  feet
  - $D = 90$  degrees,  $T = 9$  seconds,  $H = 8$  feet
- **East through northeast waves bracket the trade wind wave energy**
- **Water Levels Considered:**  
**MSL and MHHW plus 1.0 feet**





# *Bellows Beach – Bathymetric Map*



**Bathymetric Contours –  
Contours are in feet  
relative to MLLW in 2-foot  
intervals.**



# Wave Crest Orientation



\*\* Wave Conditions for  
numerical model BOUSS2D,  
Dir = ENE,  $H_s = 6$  ft.,  $T = 8$  s



# ***Sand Sources***



# Hawaii DLNR

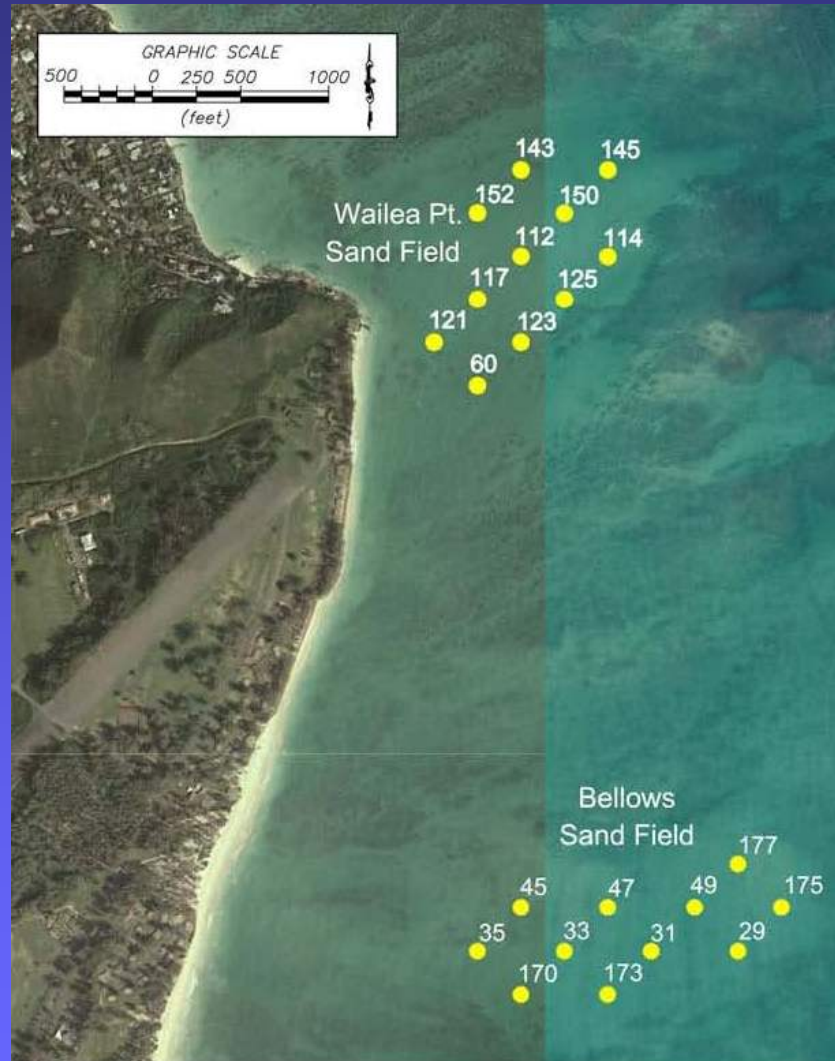
## Beach Sand Guidelines



- **Must not contain more than 6% silt material (sand grain size smaller than 0.074 mm)**
- **Must not contain more than 10% coarse material (sand grain size greater than 4.76 mm)**
- **Must have a grain size distribution that falls within 20% of the existing beach grain size distribution**
- **The overfill ratio of the fill sand shall not exceed 1.5**
- **No more than 50% of the fill sand shall have a grain diameter less than 0.125 mm**
- **Must be free of contaminants such as silt, clay, sludge, organic matter, turbidity, grease, pollutants, and others**
- **Must be dominantly composed of naturally occurring carbonate beach or dune sand.**

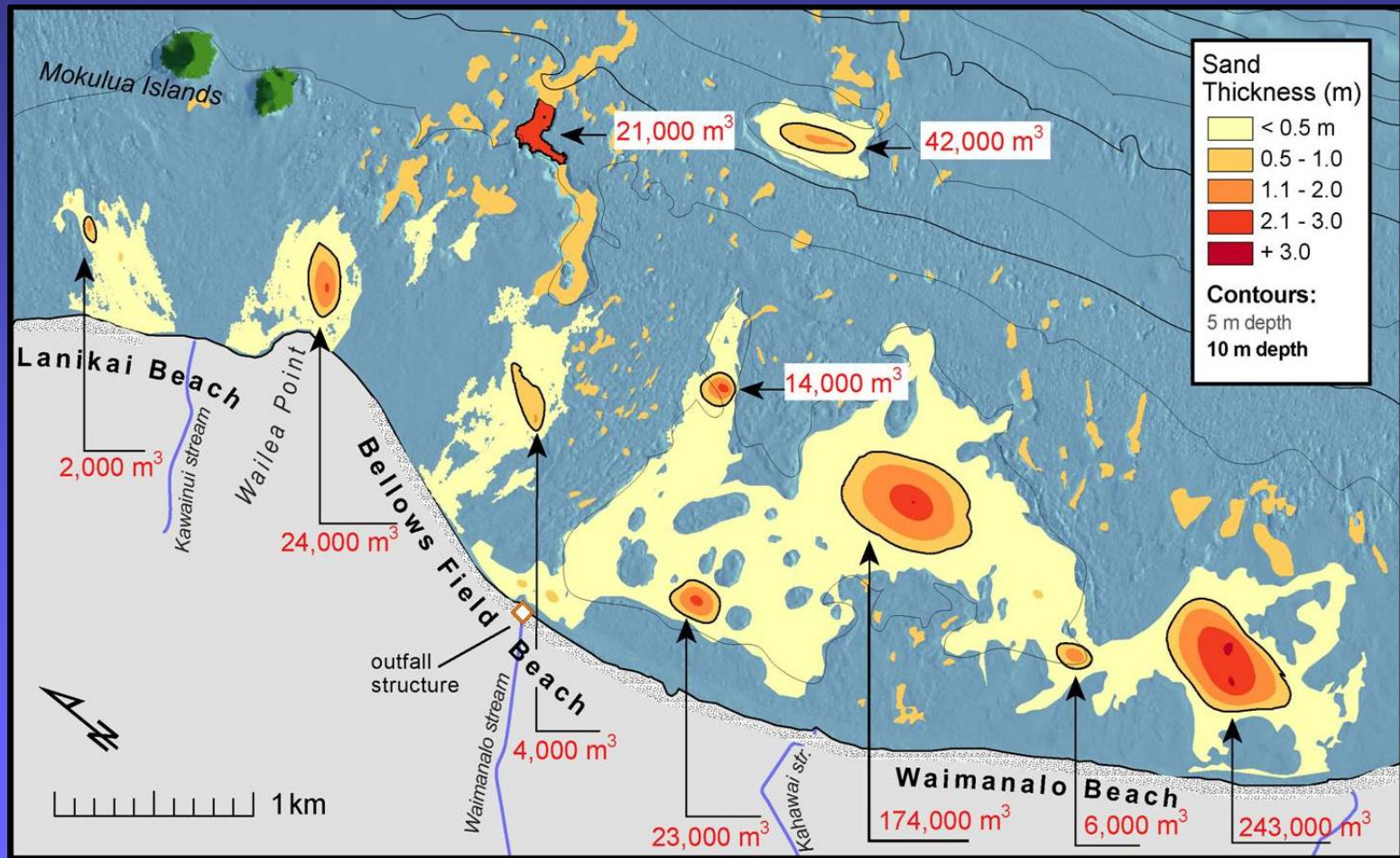


# Sand Sample Locations





# Sand Source Locations





# Possible Sand Sources

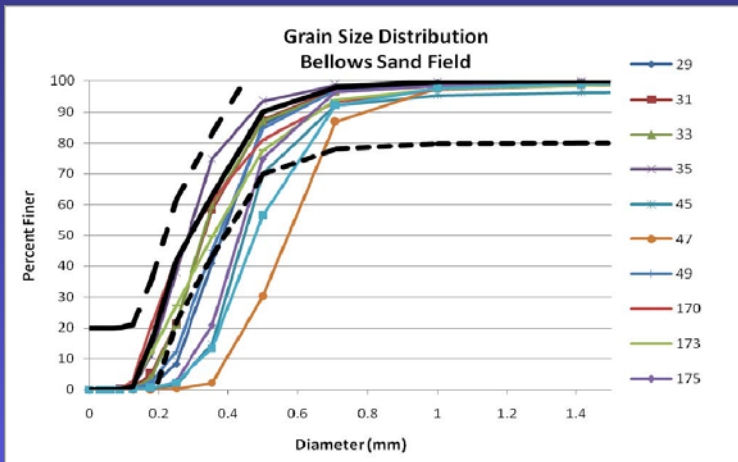


	Volume (Cu. Yd.)			
	Fossil Channel	Karst Depression	Sand Field	Total
Kailua Bay	825,115	150,715	0	975,830
Lanikai	23,616	43,703	129,987	197,306
Waimanalo Bay	0	504,396	20,136	524,532
Total	848,731	698,814	150,123	1,697,668

- Bellows and Wailea Point sand fields in Waimanalo Bay are likely sources
- Two karst deposits in Waimanalo Bay contain 417,000cy of sand but grain size data is unavailable

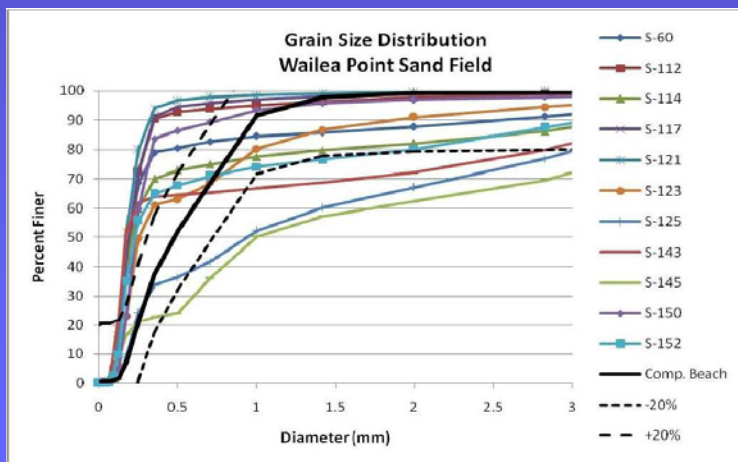


# Bellows Sand Source Grain Size Distribution



## Bellows Sand Field

- 57,660cy Available
- 0.40mm Average Grain Size
- Although coarser than existing beach sand, larger size may provide better beach stability



## Wailea Point Sand Field

- 82,740cy Available
- 0.23mm Average Grain Size
- Meets DLNR Beach Nourishment Guidelines





# Bellows Beach Nourishment

## Concept 1



# ***Concept 1 Details***



- **No structures involved in nourishment**
- **Nourishment would begin at Wailea Point and end 5,600 feet to the south at Waimanalo Stream**
- **Designed with minimum 30-foot dry beach**
- **Vegetation line is at +7 feet above MLLW and the beach face would slope towards the water at a slope of 1V:12H**
- **247,400 cubic yards of sand required**



# *Historical Shoreline 1988 Aerial Photograph*



27 Aug 2008

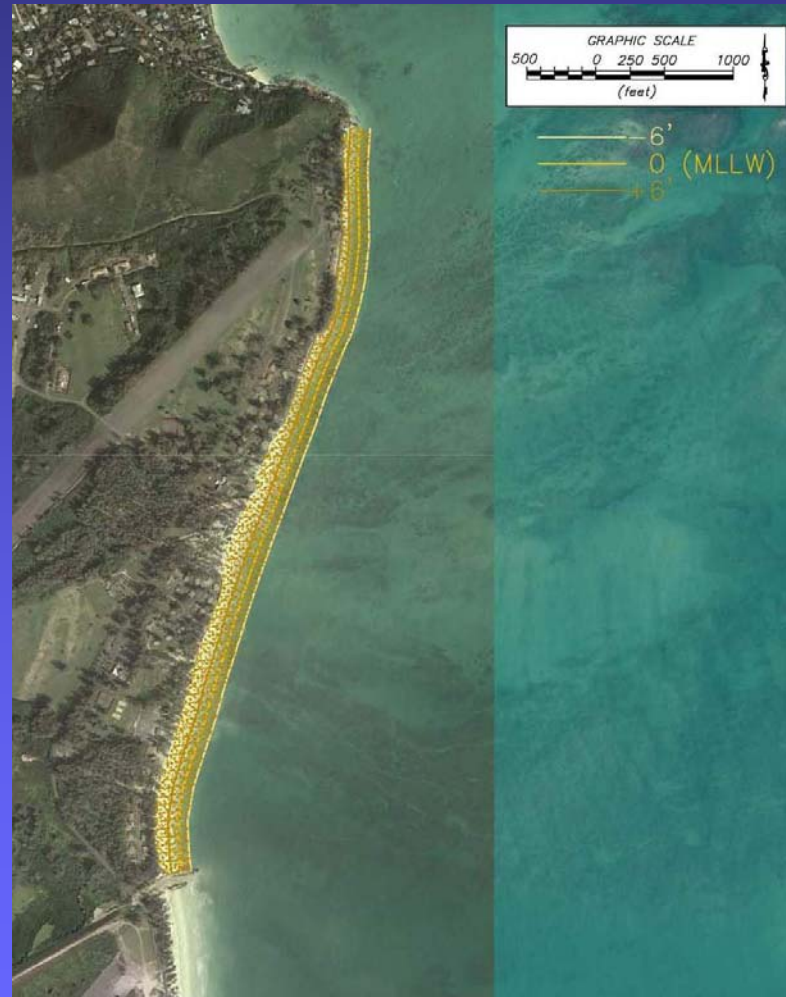
Bellows Beach Nourishment

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# Concept 1

## Bellows Beach Nourishment





# ***Estimated Construction Cost Concept 1***



<b>Item</b>	<b>Quantity</b>	<b>Unit</b>	<b>Unit Cost (\$)</b>	<b>Total Cost (\$)</b>
Site Preparation	1	Job		150,000
Environmental Protection	1	Job		100,000
Sand Fill (Includes Mob/Demob)	247,000	Cu. Yd.	150	37,110,000
Sub-Total				<b>\$37,360,000</b>
Contingency (15%)				5,604,000
<b>Total Cost</b>				<b>\$42,964,000</b>



# Bellows Beach Nourishment

## Concept 2



## ***Concept 2 Details***

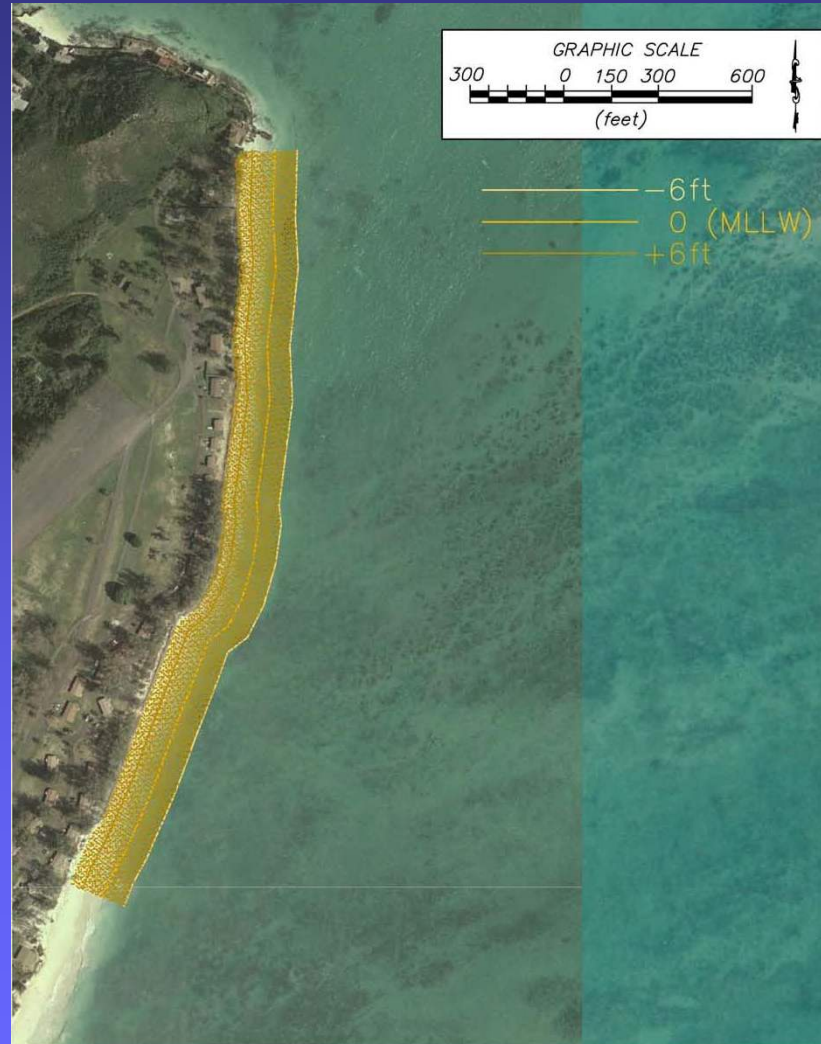


- **No structures involved in nourishment**
- **Nourishment would begin at Wailea Point and extend 200 feet past the southern end of the revetment**
- **Designed with a 30-foot dry beach in front of existing revetments**
- **Beach crest would be at +6 feet above MLLW and the beach face will slope towards the water at 1V:12H**
- **Shoreline bulge may lead to increased erosion due to its irregularity from the rest of the shoreline**
- **105,600cy of sand will be required**



# Concept 2

## Bellows Beach Nourishment







# ***Estimated Construction Cost Concept 2***



<b>Item</b>	<b>Quantity</b>	<b>Unit</b>	<b>Unit Cost (\$)</b>	<b>Total Cost (\$)</b>
Site Preparation	1	Job		150,000
Environmental Projection	1	Job		100,000
Sand Fill (Includes Mob/Debmob)	105,600	Cu. Yd.	150	15,840,000
Sub-Total				<b>\$16,090,000</b>
Contingency (15%)				2,414,000
<b>Total Cost</b>				<b>\$18,504,000</b>



# ***Bellows Beach Nourishment***

## **Concept 3**



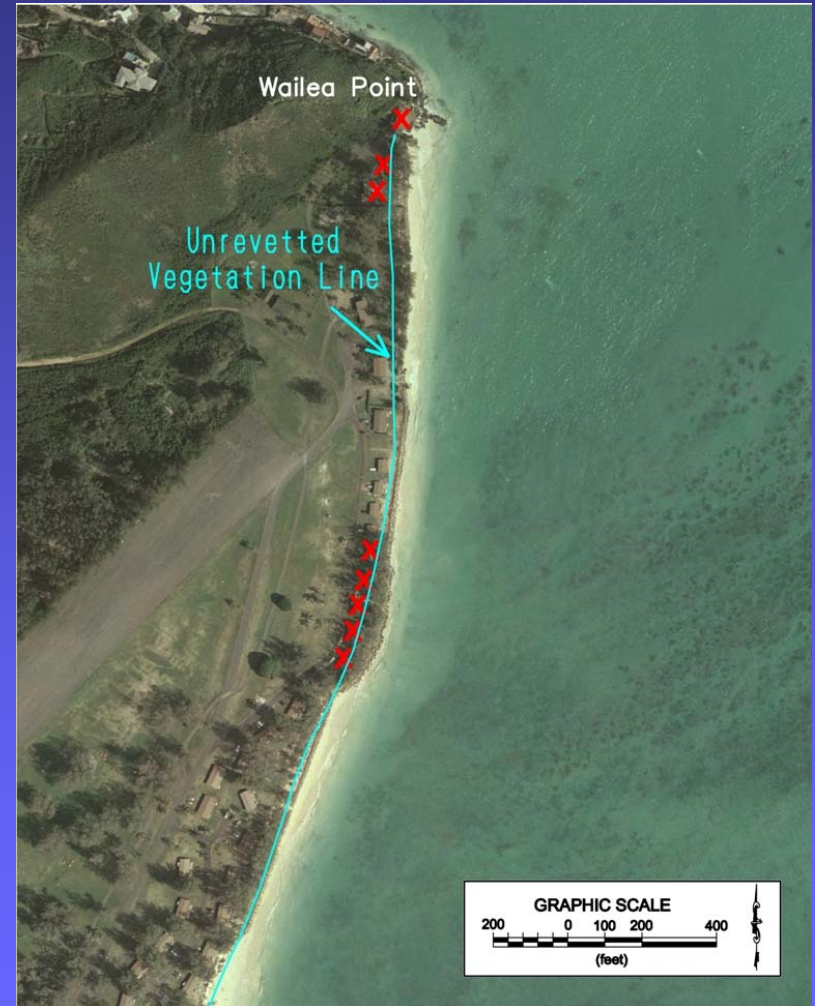
## ***Concept 3 Details***



- **Existing revetment would be removed**
- **Would create a more natural shoreline orientation**
- **Vegetation line would equilibrate as much as 52 feet inland**
- **Adjacent upland structures would be affected by this conceptual plan**



# Concept 3 Beach Nourishment – Bellows Beach





# ***Estimated Construction Cost Concept 3***



<b>Item</b>	<b>Quantity</b>	<b>Unit</b>	<b>Unit Cost (\$)</b>	<b>Total Cost (\$)</b>
Site Preparation	1	Job		150,000
Environmental Protection	1	Job		100,000
Revetment Removal (Includes Mob/Demob, 15% Contingency)	2,600	LF	200	460,000
<b>Total Cost</b>				<b>\$710,000</b>

## **Additional Costs Incurred from Shoreline Recession:**

- **Loss of existing cabins**
- **Loss of revenue from cabins**
- **Property damage to loss of existing usable land**



# Concept Cost Comparison



## Concept 1

- Initial Volume: 247,400 CY
- Renourishment Interval: 12 Yrs
- First Cost: \$42 M
- 50-Yr Total Cost: \$95 M

## Concept 1

- Initial Volume: 105,600 CY
- Renourishment Interval: 10 Yrs
- First Cost: \$19 M
- 50-Yr Total Cost: \$55 M

## Concept 3

- Revetment Length: 2,600 LF
- First Cost: \$710,000
- Loss of Land: N/A
- Loss of Structures: N/A
- Loss of Revenue: N/A
- 50-Yr Total Cost: Unknown



***THANK YOU***