

### **3 TRANSIENT, MILES-LONG CLUSTERS OF ELEVATED ENTEROCOCCUS ALONG MONMOUTH AND OCEAN COUNTIES, AND THE POTENTIAL ROLE OF THE HUDSON-RARITAN PLUME**

Recreational beach water quality monitoring for the Cooperative Coastal Monitoring Program (CCMP) occurs in 4 coastal counties in NJ every Monday (or Tuesday if Monday is a holiday). In Monmouth County, about 60 bay and ocean stations are sampled between 730-1030 AM from May through September. Ocean recreational beaches are subject to opening and closing procedures of the State Sanitary Code and must be resampled (usually on Tuesday at 3 stations, the original failure plus 2 brackets) when initial bacteria concentrations from Monday's sampling exceed the primary contact standard of 104 enterococci per 100 mL of sample (<http://www.njbeaches.org/>).

In 2004, enterococcus replaced fecal coliform as the indicator bacteria, because it predicts disease rates and because it survives longer in marine water.

Since 2004, there have been 3 (out of about 420) unusual sampling events where there were miles-long clusters of enterococcus exceedences from the initial sampling taken along the ocean coastline in areas both with and without local storm drains. In all 3 cases all resampling results dropped well below the standard the following day. There have been two during dry weather in Monmouth County and one during wet weather. The wet weather cluster extended 25 miles from the north end of Sandy Hook to Seaside Park in Ocean County.

At the meeting of the NJ Water Monitoring Council on 9/22/10, the MCHD gave an overview of this third event to the group and requested that the DEP and Rutgers begin working to specifically understand what rare and ephemeral hydrodynamic conditions are able to cause the Hudson Raritan plume, directly or indirectly, to become the predominant source of elevated bacteria levels along the NJ coast.

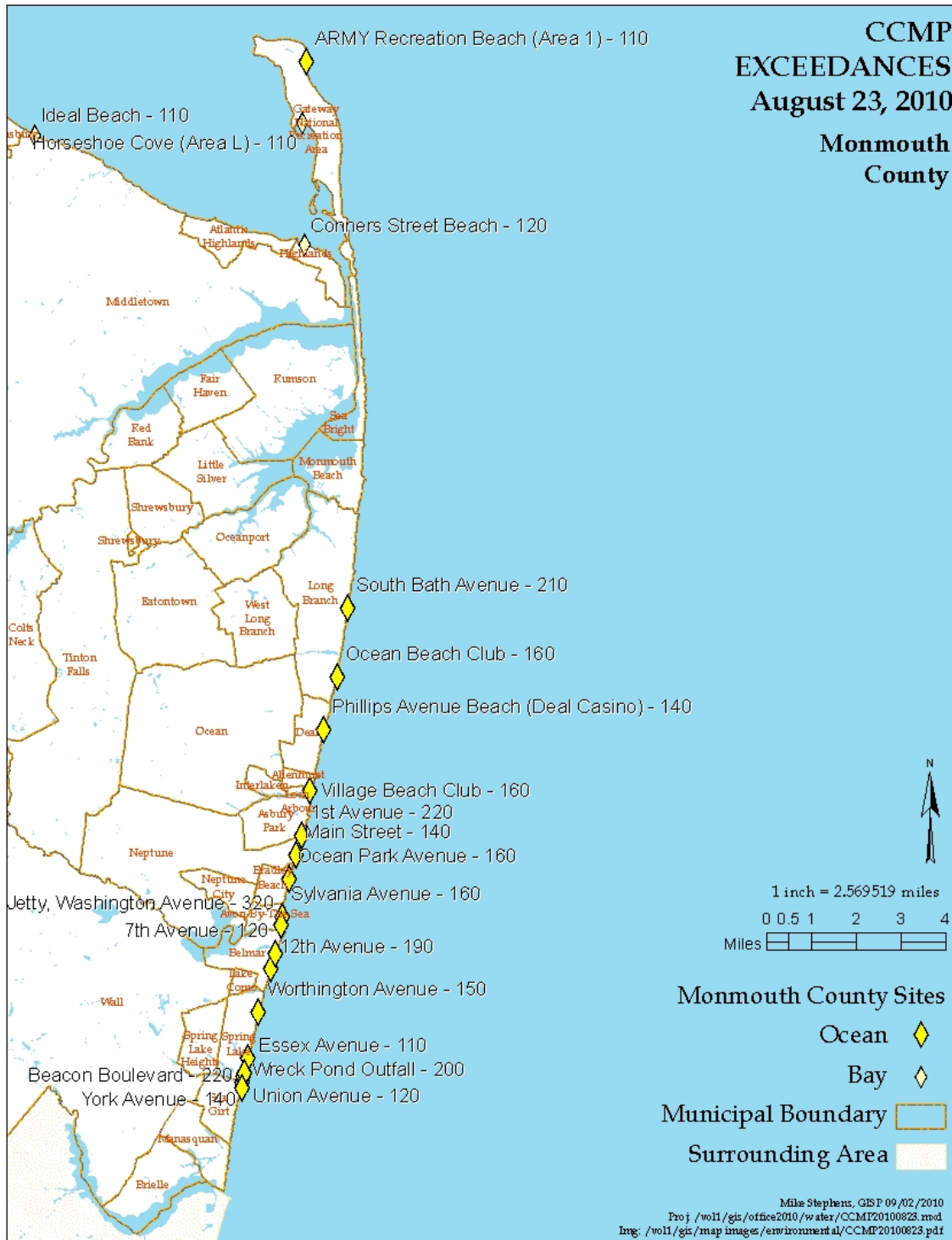
#### **I. 8/23/2010 (Wet Weather, 25 Ocean Exceedences in 2 Counties, 38 miles)**

On 8/23/10, Monmouth County had 21 CCMP exceedences (4 in estuary, 1 outfall, 16 along the ocean) and Ocean County had 16 (9 estuary, 9 ocean). All 75 ocean resamples (3 per original failure) in both counties (as well as the 3 bay resamples at Ideal Beach in Monmouth) dropped below the standard by Tuesday morning's resampling on 8/24/10.

The 2 independent county health departments use 2 different labs: the MCHD uses Henderson Labs in Beachwood, and the OCHD uses the OC Utility Authority.

Health Departments in Monmouth posted 17 out of 18 single day advisories about the elevated bacteria on 8/23 (the National Park Service at Sandy Hook did not issue an advisory at Sandy Hook because federal policy does not allow it, and the other sites with exceedences in Monmouth were non-bathing beaches).

**CCMP  
EXCEEDANCES  
August 23, 2010  
Monmouth  
County**





The ocean exceedances started at the 2 most northern bay and ocean CCMP sites on Sandy Hook, closest to where the Hudson-Raritan Bay plume discharges into the ocean. There were no exceedances along the rest of Sandy Hook, Sea Bright, Monmouth Beach and northern Long Branch. Exceedances resumed near the storm water outfall at the South Bath Av. site in Long Branch

and continued until a few blocks south of the pier at Seaside Park in Ocean County – about 25 miles (LB-SP). There are a number of storm water outfalls in Monmouth County from Long Branch to Sea Girt, but there are no storm water outfalls past the Manasquan River and Point Pleasant Beach outfall during the last 10 miles of exceedences in Ocean County at the 8 stations between PPB and Seaside Park in Ocean County. The approximate distances are: 38 miles from Sandy Hook to Seaside Park; 12 miles from Sandy Hook to Long Branch; 25 miles from Long Branch to Seaside Park; 11.5 miles from the Manasquan River to Seaside Park; 4.5 miles from the Manasquan River to Mantoloking; 7 miles from Mantoloking to Seaside Park; 11 miles from Seaside Park to Barnegat Light.

Unusually, only 4 of the 16 bay sites in Monmouth had exceedences, compared with 16 exceedences out of the 43 ocean sites. Normally, when the ocean has this many exceedences the bay does too, when the exceedences are due to local rainfall and runoff. However, the rain in Monmouth County on Sunday was only moderate, probably less than a 6 month storm-frequency.

WX SITE INCHES OF RAIN	8/22/2010	8/23/2010	8/24/2010
	SUN	MON	TUES
KEANSBURG	0.36	0.05	0.05
HOLMDEL	0.63	0.26	0.49
OAKHURST	0.35	0.09	0.31
BRADLEY BCH	0.09	0.1	0.2
SEA GIRT	0.22	0.11	0.24
WARETOWN	0.61	0.06	0.15

Significantly, this was the first multi-day soaking storm all summer, and previous storms had been popup showers that were sporadically distributed and short lived. It had also been several weeks since the last rainfall; and we have seen the number of exceedences at the ocean increase when preceded by rainfall after an antecedent period of 1.5-2 weeks of dry weather. This is presumably due to the increase in the buildup of animal droppings during dry weather. So this rainfall may have produced runoff that was comparatively dense with bacteria because it was the first area wide storm in several weeks and because of the extended dry period that preceded it.

Note that the while Waretown rain gage across from the Barnegat Inlet had almost the highest amount of rain on Sunday, there were no exceedences at the ocean beaches near where the Inlet discharges into the ocean. Exceedences stopped a few blocks south of the Seaside Pier, about 10 miles to the north (but this is also I believe somewhere near where the CCMP sampling stations end until south of the Barnegat Inlet). Significantly, there was an exceedence in the estuary near the inlet, but since there were no exceedences at ocean beaches south of the Inlet on Long Beach Island, it is unlikely that the stormwater exiting the Inlet is the source of the exceedences at Seaside Park.

Since there are 9 sewer outfalls that discharge into the ocean from Sandy Hook to Seaside Park, DEP-Enforcement was specifically requested by the MCHD to advise if any sewer plants along the Monmouth and Ocean coastline reported bypasses or malfunctions over the weekend. That none were reported is consistent with the moderate rainfall reported locally. However, sewer plants in New York reported bypasses, as they normally do after most rain events. Combined Sewer Overflows (CSOs) in the metropolitan area (starting in Perth Amboy, 250 in NJ, and 450 in NY) also routinely discharge raw sewage, some when it rains as little as 0.1".

Northerly and northeast winds that occurred during this event cause the Hudson-Raritan plume to downwell along the beach, and pin local stormwater discharges against the shoreline. Additionally, the moderate amount of local rain may have produced a less forceful discharge that would tend to be overwhelmed by the downwelling force of the H-R plume, and so be less likely to clear out past the nearshore.

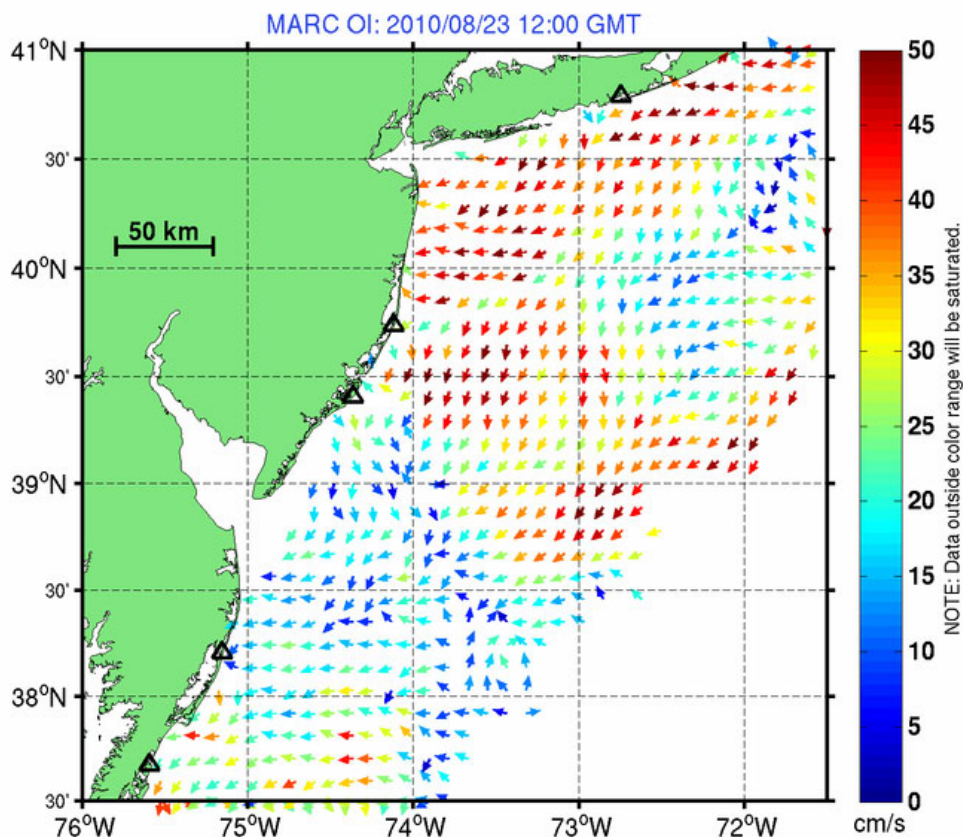
The force of the downwelling currents is evident on the Rutgers Institute of Marine and Coastal Science webpage "Rutgers University Coastal Ocean Observation Lab CODAR: Mid-Atlantic Bight - Center: Surface Currents".

## CODAR: Mid-Atlantic Bight - Center: Surface Currents

Current archived images are available between 1/1/2009 and 9/21/2010 8:00 . Images are available every hour on the hour.

Date:  Hour:

Region:  Map Type:



<http://rucool.marine.rutgers.edu/index.php/CODAR-Mid-Atlantic-Bight-Center/>

At 1:00 AM (5:00 GMT) on Monday 8/23/10, about an hour before low tide at Sandy Hook, current direction begins to predominate from the east and north. By the start of sampling around 8:00 AM (12 GMT), which was also the peak of high tide, the currents were driving into the Monmouth and Ocean coastline from the east and had significantly increased in velocity. It is possible that this may have contained rainfall runoff, locally and/or from the Hudson River plume, in the nearshore. Rainfall had ended locally from 10 to 18 hours earlier. The timing of the rainfall on Sunday (8/22/10) in Sea Girt was that all the rain fell between noon and 2:00 PM; and at Oakhurst, the rain fell between 2:00-3:00 and 6:40-10:00 PM (see Appendix for rain links). Sampling occurred around high tide (7:56 at Sandy Hook), and there would be a full moon 2 days later on 8/25.

As the CODAR webpage demonstrates, the velocity of the onshore currents continued through the afternoon. Around 3:00 PM (19 GMT), the predominant current direction from the east and north became mixed; it changed to being predominantly from the east and southeast around 8:00PM (0 GMT on 8/24); then changed to being predominantly from the east and northeast from 3:00 AM on 8/24/10 (7 GMT) through the time of resampling on Tuesday. In Monmouth resampling occurred from about 10:45 (14:45 GMT) to noon (1600 GMT).

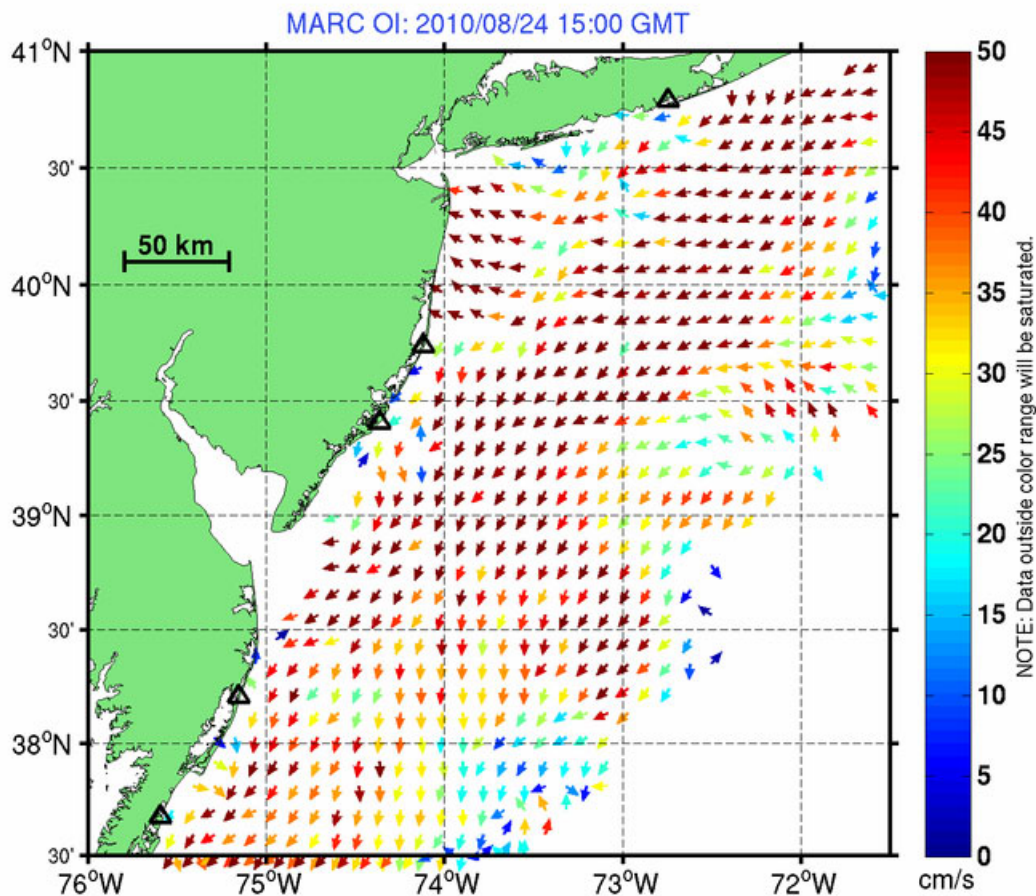
The resamples all resulted in significantly lower enterococcus levels, with no coastal exceedences in either county. In Monmouth, about 40 of the 53 resamples were below the detection limit of 10 colonies. The leading edge of the 25-mile long coastline plume from Monday morning appears to have become diluted by the high-velocity currents from the east, which drove in offshore ocean water that flushed the coastline by the time resamples were taken 24 hours later on Tuesday morning.

## CODAR: Mid-Atlantic Bight - Center: Surface Currents

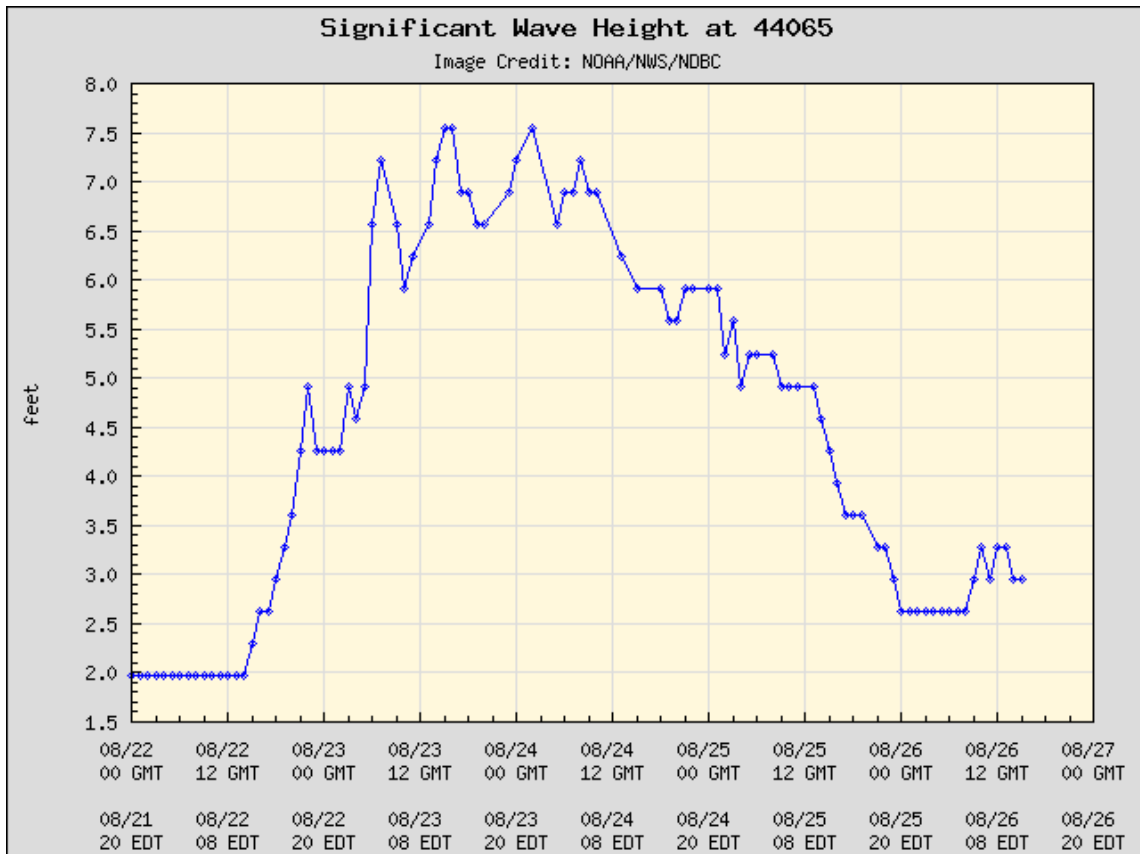
Current archived images are available between 1/1/2009 and 9/21/2010 9:00 . Images are available every hour on the hour.

Date:   Hour:

Region:  Map Type:



Sampling occurred following high tide (7:56 at Sandy Hook); there would be a full moon 2 days later on 8/25. Large storm waves stir up the bottom and can suspend sediments from nearby storm water outfalls and resuspend the wrack line on the beach, both of which can be sources of bacteria. However this does not explain why the exceedences did not occur in other areas to the north of the south of the cluster.



[http://www.ndbc.noaa.gov/show\\_plot.php?station=44065&meas=sght&uom=E&time\\_diff=-4&time\\_label=EDT](http://www.ndbc.noaa.gov/show_plot.php?station=44065&meas=sght&uom=E&time_diff=-4&time_label=EDT)

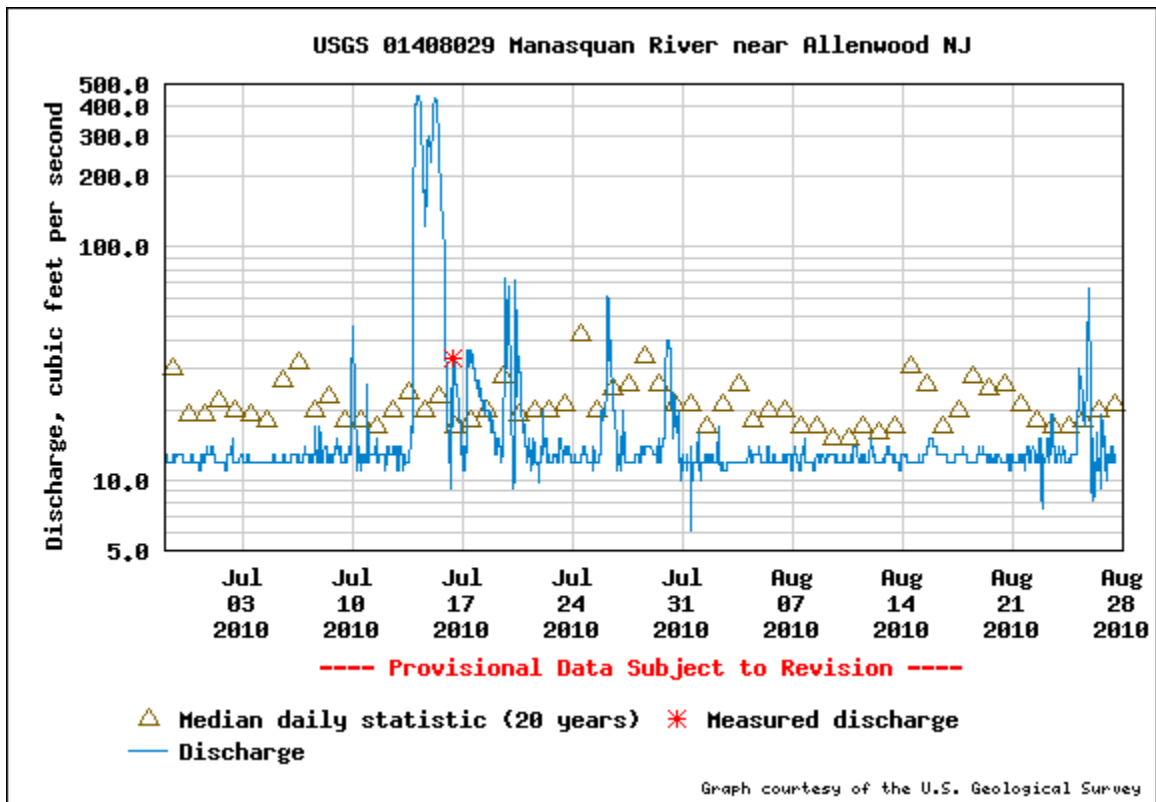
The streamflow gage on the Manasquan at Allenwood for 8/22 and 8/23 indicated that the volume of the discharge was lower than previous storms within 60 days (about 20 cfs), so the rain-related discharge from the Manasquan River does not appear to be unusually large enough to account for the number of exceedences in Ocean County all the way to Seaside Park. The Shark River near Neptune City (25 cfs) was comparable to previous storms in the watershed within 60 days. In contrast, the gage on Hudson River at Poughkeepsie (the closest stream gage to NYC) shows a relatively significant storm within 60 days (35,000 cfs).

Since there are no storm drains along the ocean in Monmouth from Sandy Hook to Monmouth Beach, and the area in Monmouth with the exceedences has a number of storm drains or lake outfalls (see Appendix), it is reasonable to conclude at first that the downwelling forced locally-derived bacteria against the shoreline. What is different in the 11 mile area with the exceedences in Ocean County is that the only stormwater sources are the Manasquan River and a storm outfall in Point Pleasant Beach, and there are none for the next 10 miles of exceedences to Seaside Park.

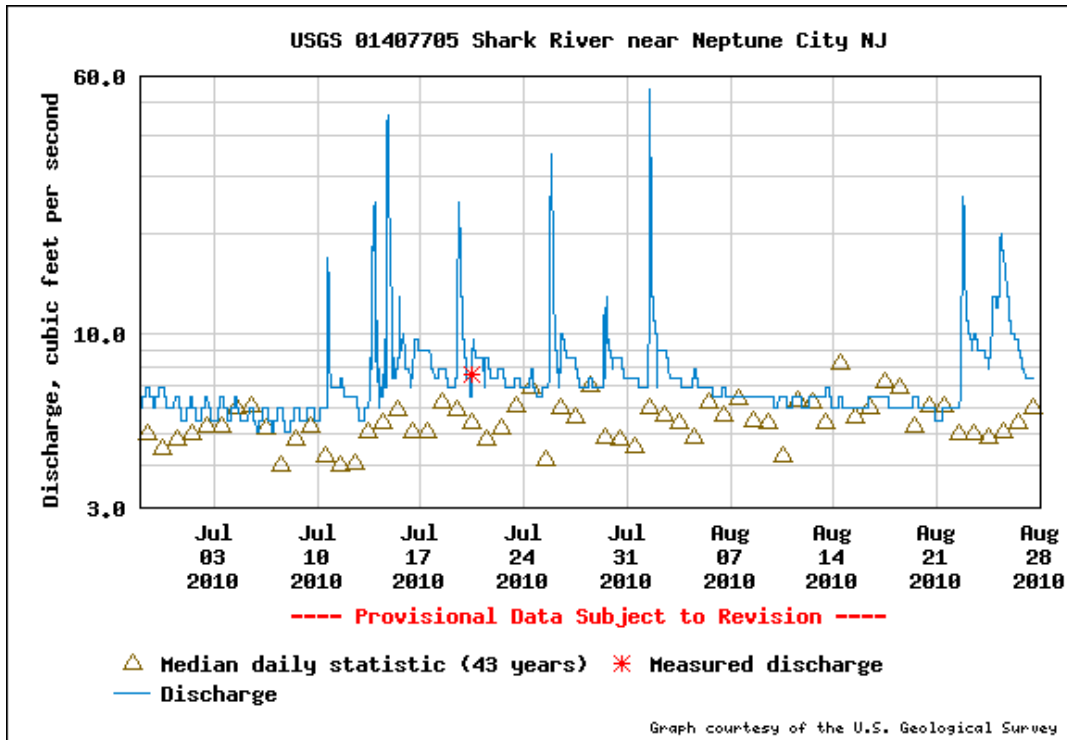
These discharges are consistent with the rain forecast for the region:

“The heaviest rainfall will clearly fall over the Hudson Valley, the five boroughs of New York, Long Island, and Connecticut over the next three days with one to three inches of rain possible between this evening and Wednesday evening. The rest of the region will average between a half an inch and an inch of rain through Wednesday evening as the rain will be scattered and not as intense as the best lifting will be focused over the New York City metropolitan area and points north and east.”

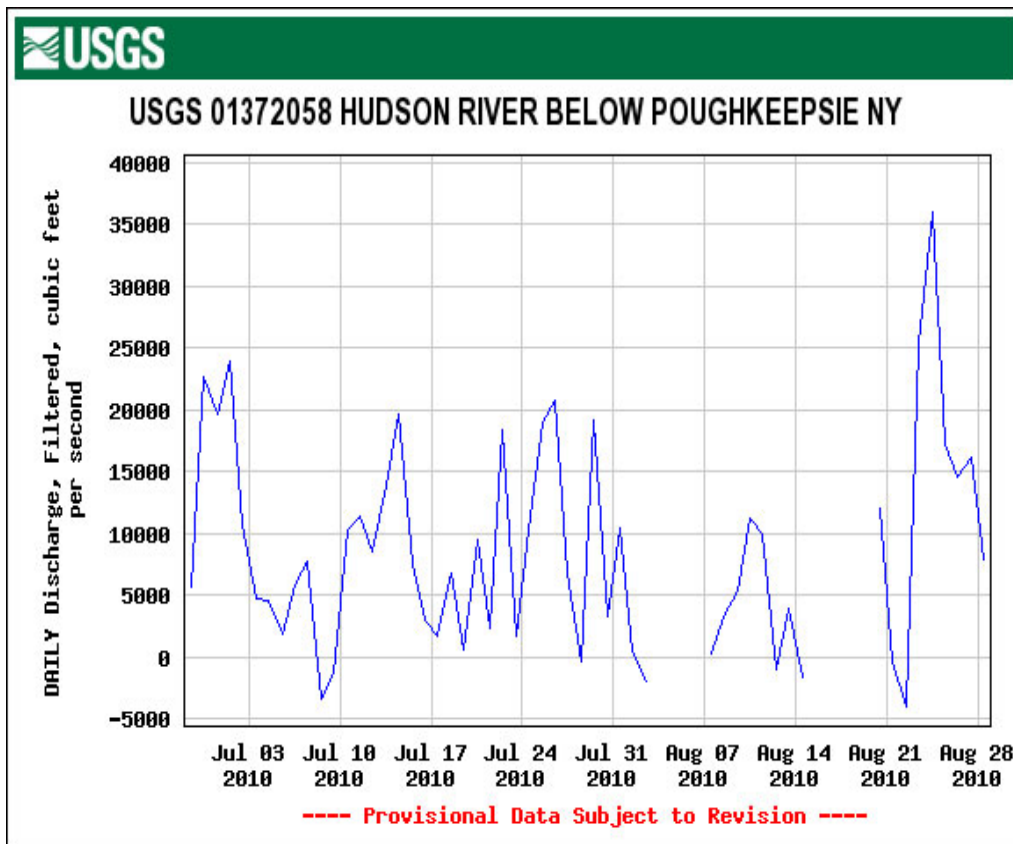
<http://www.nynjpawweather.com/2010/08/22/strong-upper-low-to-keep-northern-mid-atlantic-unsettled/>



[http://waterdata.usgs.gov/nwisweb/graph?agency\\_cd=USGS&site\\_no=01408029&parm\\_cd=00060&period=60](http://waterdata.usgs.gov/nwisweb/graph?agency_cd=USGS&site_no=01408029&parm_cd=00060&period=60)



[http://waterdata.usgs.gov/nwisweb/graph?agency\\_cd=USGS&site\\_no=01407705&parm\\_cd=00060&period=60](http://waterdata.usgs.gov/nwisweb/graph?agency_cd=USGS&site_no=01407705&parm_cd=00060&period=60)



[http://waterdata.usgs.gov/nwis/dv/?dd\\_cd=37\\_00060\\_00003&format=img\\_default&site\\_no=01372058&begin\\_date=20100628&end\\_date=20100828](http://waterdata.usgs.gov/nwis/dv/?dd_cd=37_00060_00003&format=img_default&site_no=01372058&begin_date=20100628&end_date=20100828)

See Appendix for other data.

## **II. 9/10/2007 (Dry Weather, 7 Ocean Exceedences in 3 miles with Storm Drains)**

There was a dry weather plume on 9/10/07. Seven CCMP sites had elevated enterococcus, levels from Allenhurst to Belmar (from Deal lake to the north to the Shark River). The next day, the sampling results were all well below standard (the highest was 50 colonies).

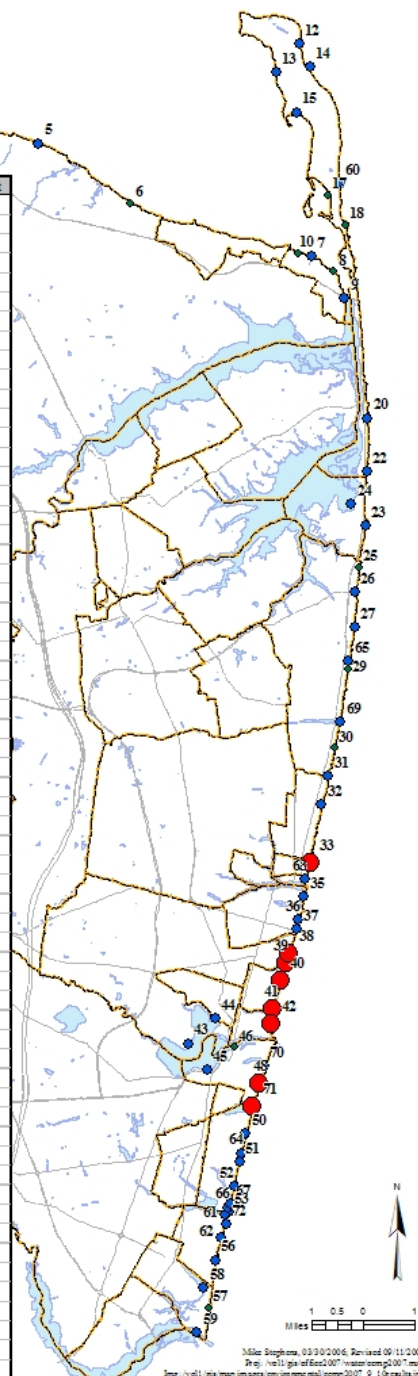
Coincident with this was a new moon, easterly winds, and larger than normal waves that may have been resuspending debris from wrack lines. These exceedences were clustered within a 3-mile area.

Josh Kohut of the Rutgers Institute of Marine and Coastal Science forwarded a Chlorophyll A map dated 9/9/10. It showed "that the Hudson River plume is moving more like a wave down the coast. You can see that the High CHI regions (orange to red) comes into contact with the beach then moves back offshore. It repeats this a couple times. Please note that these images are from Sunday (The last clear day)."

# Monmouth County Health Department CCMP 09-10-2007 Results



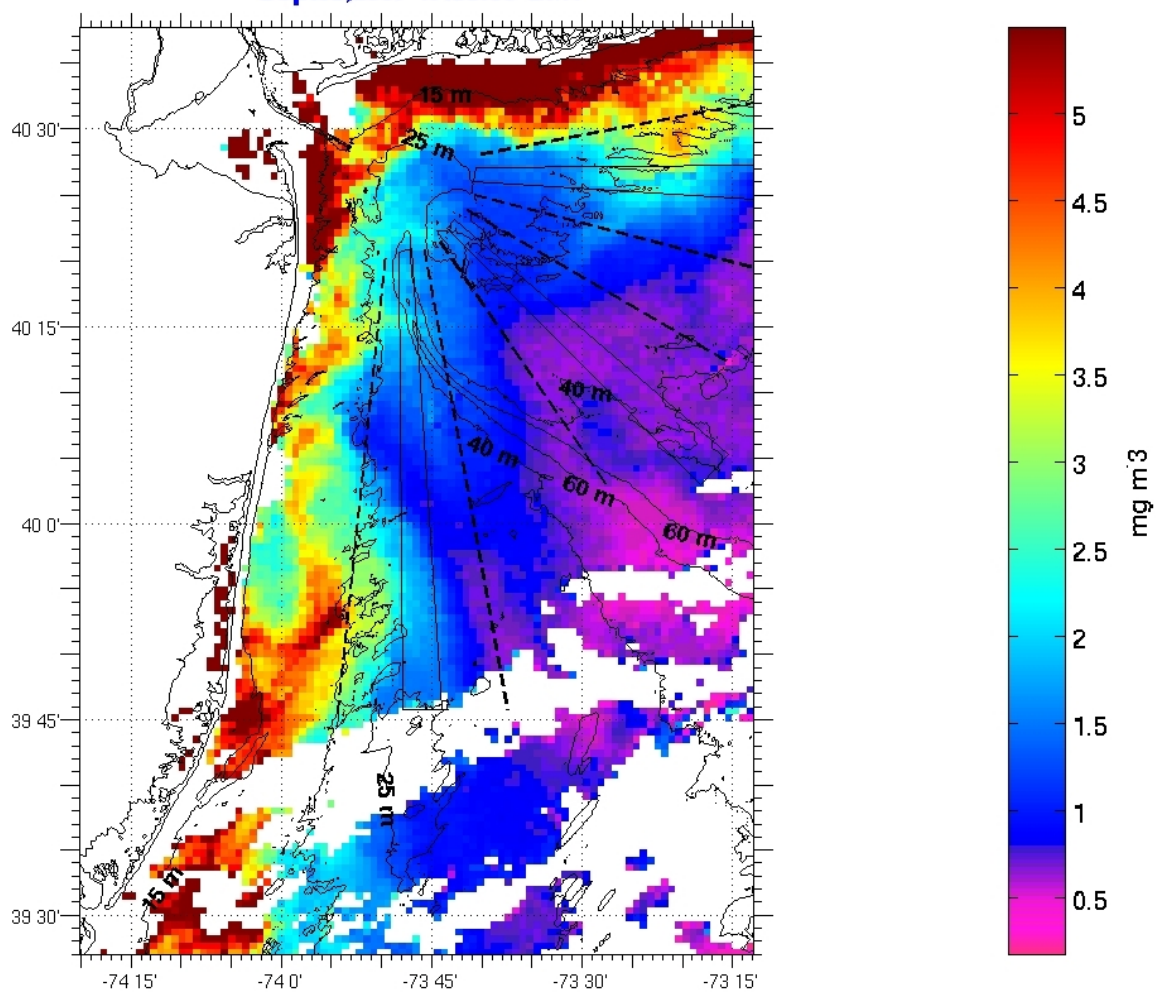
BOTTLE	SITE	TOWN	Result
1	BROAD STREET - NON-BATHING	KEYPORT	< 10
2	FRONT STREET - NON-BATHING	UNION BEACH	50
3	BEACHWAY & RARITAN - NON-BATHING	KEANSBURG	< 10
4	IDEAL BEACH - BATHING	MIDDLETOWN	< 10
5	FORT MONMOUTH & WILSON AVENUE - NON-BATHING	FORT MONMOUTH	10
6	THOMPSON AVENUE - BATHING	LEONARDO	< 10
7	RECREATION CENTER - BATHING	HIGHLANDS	20
8	MILLER STREET BEACH - BATHING	HIGHLANDS	< 10
9	SOUTH BAY AVENUE BEACH - BATHING	HIGHLANDS	20
10	CONNERS STREET BEACH - BATHING	HIGHLANDS	< 10
12	ARMY RECREATION BEACH - BATHING	SANDY HOOK	10
13	SANDY HOOK LIGHT - NON-BATHING	SANDY HOOK	10
14	FORT HANCOCK STP - BATHING	SANDY HOOK	10
15	HORSESHOE COVE - NON-BATHING	SANDY HOOK	20
17	SPERMACEITTI COVE - NON-BATHING	SANDY HOOK	< 10
18	SURF BEACH - BATHING	SANDY HOOK	< 10
20	PUBLIC BATHING BEACH - BATHING	SEA BRIGHT	10
22	ISLAND VIEW WAY & OCEAN AVENUE - NON-BATHING	SEA BRIGHT	70
23	MONMOUTH BEACH CLUB - BATHING	MONMOUTH BEACH	30
24	WARFIDE MANOR CONDOS, PARK AVENUE - NON-BATHING	MONMOUTH BEACH	10
25	7 PRESIDENT'S PARK, ATLANTIC AVENUE - BATHING	LONG BRANCH	< 10
26	JOLINE AVENUE - BATHING	LONG BRANCH	50
27	LAIRD ST - BATHING	LONG BRANCH	60
29	SOUTH BATH AVENUE - NON-BATHING	LONG BRANCH	< 10
30	OCEAN BEACH CLUB - BATHING	LONG BRANCH	< 10
31	ELBERON BATHING CLUB - BATHING	ELBERON	20
32	DEAL CASINO - BATHING	DEAL	30
33	CEDAR AVENUE - BATHING	ALLENHURST	180
35	7TH AVENUE - BATHING	ASBURY PARK	50
36	3RD AVENUE - BATHING	ASBURY PARK	70
37	ASBURY AVENUE - BATHING	ASBURY PARK	80
38	MAIN AVE - BATHING	OCEAN GROVE	130
39	BROADWAY - BATHING	OCEAN GROVE	210
40	OCEAN PARK AVENUE - BATHING	BRADLEY BEACH	150
41	EVERGREEN AVENUE SOUTH - BATHING	BRADLEY BEACH	270
42	SYLVANIA AVENUE - BATHING	AVON	120
43	RIVERSIDE & THE PLAZA - BATHING	NEPTUNE TWP.	50
44	MYRON & WILSON AVE - NON-BATHING	NEPTUNE CITY	50
45	L STREET - BATHING (RAIN PROVISIONAL)	BELMAR	40
46	ROUTE 71 BRIDGE - NON-BATHING	BELMAR	< 10
48	12TH AVENUE - BATHING	BELMAR	320
50	WORTHINGTON AVENUE - BATHING	SPRING LAKE	70
51	WASHINGTON AVE - BATHING	SPRING LAKE	30
52	ESSEX AVENUE - BATHING	SPRING LAKE	20
53	BROWN AVENUE SOUTH - BATHING	SPRING LAKE	60
56	NEPTUNE PLACE - BATHING	SEA GIRT	60
57	EAST MAIN STREET - BATHING	MANASQUAN	< 10
58	STOCKTON LAKE - NON-BATHING	MANASQUAN	20
59	FISHERMAN'S COVE, MANASQUAN RIVER - NON-BATHING	MANASQUAN	10
60	AREA E - BATHING	SANDY HOOK	100
61	THE TERRACE - BATHING	SEA GIRT	60
62	PHILADELPHIA BOULEVARD - BATHING	SEA GIRT	30
63	VILLAGE BEACH CLUB - BATHING	LOCH ARBOR	20
64	NEWARK AVE - BATHING	SPRING LAKE	30
65	NORTH BATH AVENUE - BATHING	LONG BRANCH	20
66	YORK AVE - BATHING	SPRING LAKE	100
68	BEACON BLVD - BATHING	SEA GIRT	20
69	LAKE TAKANASSEE BEACH CLUB - NON-BATHING	ELBERON	20
70	7TH AVE - BATHING	BELMAR	20
71	20TH AVE - BATHING	BELMAR	540
72	CHICAGO BLVD - BATHING	SEA GIRT	20



Mike Stephens, 03/02/2006, Revised 05/11/2007  
 Proj: 10110 gis of 06/2007/10110 comp 06/2007.mxd  
 Dmg: 10110 gis map image 06/2007/10110 comp 06/2007\_2\_1 10110.mxd

**RU COOL MODIS: Aqua Chlorophyll (OC3M)**

**Sep.09,2007 17:56:00 GMT**



### III. 6/6/2005 (Dry Weather, 6 Ocean Exceedences in 5 Miles, 2.5 Miles Without Storm Drains)

There was a dry weather plume of bacterial exceedences on 6/6/05, smaller than the one on 9/10/07, in the area where the Hudson-Raritan plume often impacts the shoreline in Monmouth County, from Sea bright to Long Branch. Resamples taken on 6-07-05 were all 10 or less than 10 colonies.

BOTTLE	ORDER FROM N TO S	ENT	STORM DRAIN	DATE	OCEAN BEACH SITE
20	1	140	N	06-Jun-05	SEA BRIGHT
22	2	960	N	06-Jun-05	ISLAND VIEW, MON BEACH
23	3	530	N	06-Jun-05	MON BEACH CLUB
25	4	200	Y	06-Jun-05	7 PRESIDENTS - ATLANTIC
26	5	50	Y	06-Jun-05	7 PRESIDENTS - JOLINE
27	6	140	Y	06-Jun-05	LAIRD AV LONG BRANCH
69	7	70	Y	06-Jun-05	LAKE TAKANASSE BEACH CLUB, LB
RESAMPLES TAKEN ON 6-07-05 WERE ALL 10 OR LESS THANN 10 COLONIES					

The most northerly 3 CCMP sites have no storm drains; the other 4 do. The area from Sea Bright to Lake Takanassee is about 5 miles long. Sites 1-3, that have no storm drains, are about 2.5 miles long.

There are no storm drains at Sandy Hook or along beaches to the south until the "7-Presidents – Atlantic" CCMP site, which is about 10.5 miles from the tip of Sandy Hook.

## **APPENDIX – ADDITIONAL DATA FOR 8/23/10**

### **RAIN WEBSITES USED**

#### Rutgers Wx

Holmdel and Sea Girt

<http://climate.rutgers.edu/njwxnet/dataviewer-stnpt.php>

#### Weather Underground

Oakhurst - KNJOAKHU1, Oakhurst FD Station #1, Oakhurst

Bradley Beach - KNJBRADL1, Bradley Beach

Waretown - KNJWARET2, Oyster Creek, Waretown (across from the Barnegat Inlet)

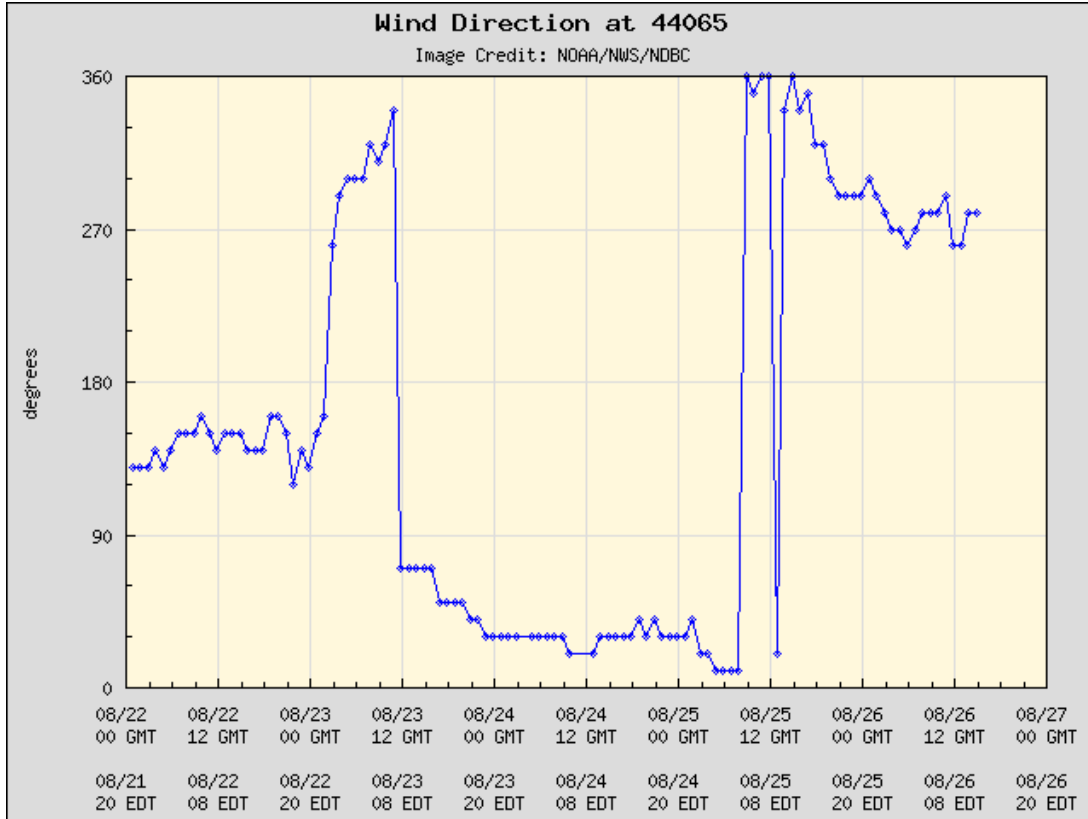
<http://www.wunderground.com/wundermap/?lat=40.29449844&lon=-73.99517822&zoom=10>

#### USGS

Keansburg

[http://waterdata.usgs.gov/nj/nwis/uv?cb\\_00045=on&format=gif\\_default&period=10&site\\_no=402657074085101](http://waterdata.usgs.gov/nj/nwis/uv?cb_00045=on&format=gif_default&period=10&site_no=402657074085101)

## WIND DIRECTION



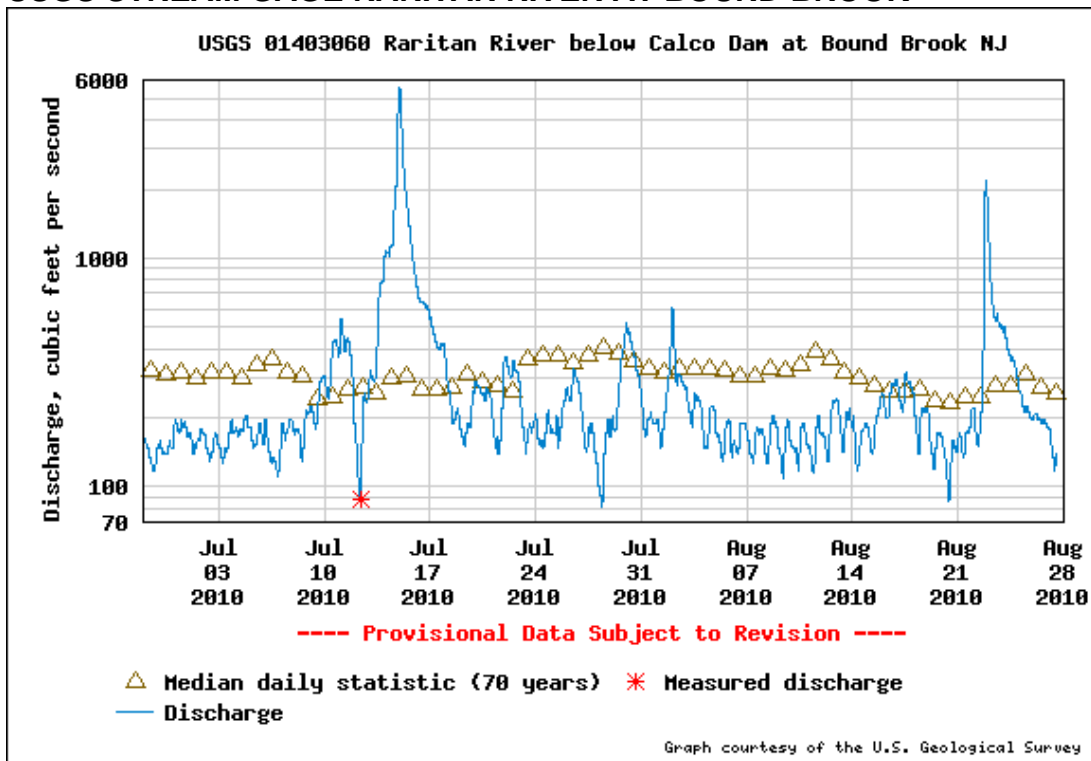
[http://www.ndbc.noaa.gov/show\\_plot.php?station=44065&meas=wdir&uom=E&time\\_diff=-4&time\\_label=EDT](http://www.ndbc.noaa.gov/show_plot.php?station=44065&meas=wdir&uom=E&time_diff=-4&time_label=EDT)

## TIDES FOR SANDY HOOK STARTING WITH AUGUST 22, 2010.

Day		High /Low	Tide Time	Height Feet	Sunrise Sunset	Moon Time	% Moon Visible
Su	22	Low	12:58 AM	0.4	6:14 AM	Set	92
	22	High	7:00 AM	4.6	7:44 PM	Rise	
	22	Low	1:04 PM	0.6			
	22	High	7:16 PM	5.3			
M	23	Low	1:39 AM	0.3	6:15 AM	Set	97
	23	High	7:42 AM	4.8	7:42 PM	Rise	
	23	Low	1:48 PM	0.5			
	23	High	7:56 PM	5.4			
Tu	24	Low	2:18 AM	0.2	6:16 AM	Set	99
	24	High	8:21 AM	4.9	7:41 PM	Rise	
	24	Low	2:30 PM	0.5			
	24	High	8:33 PM	5.4			

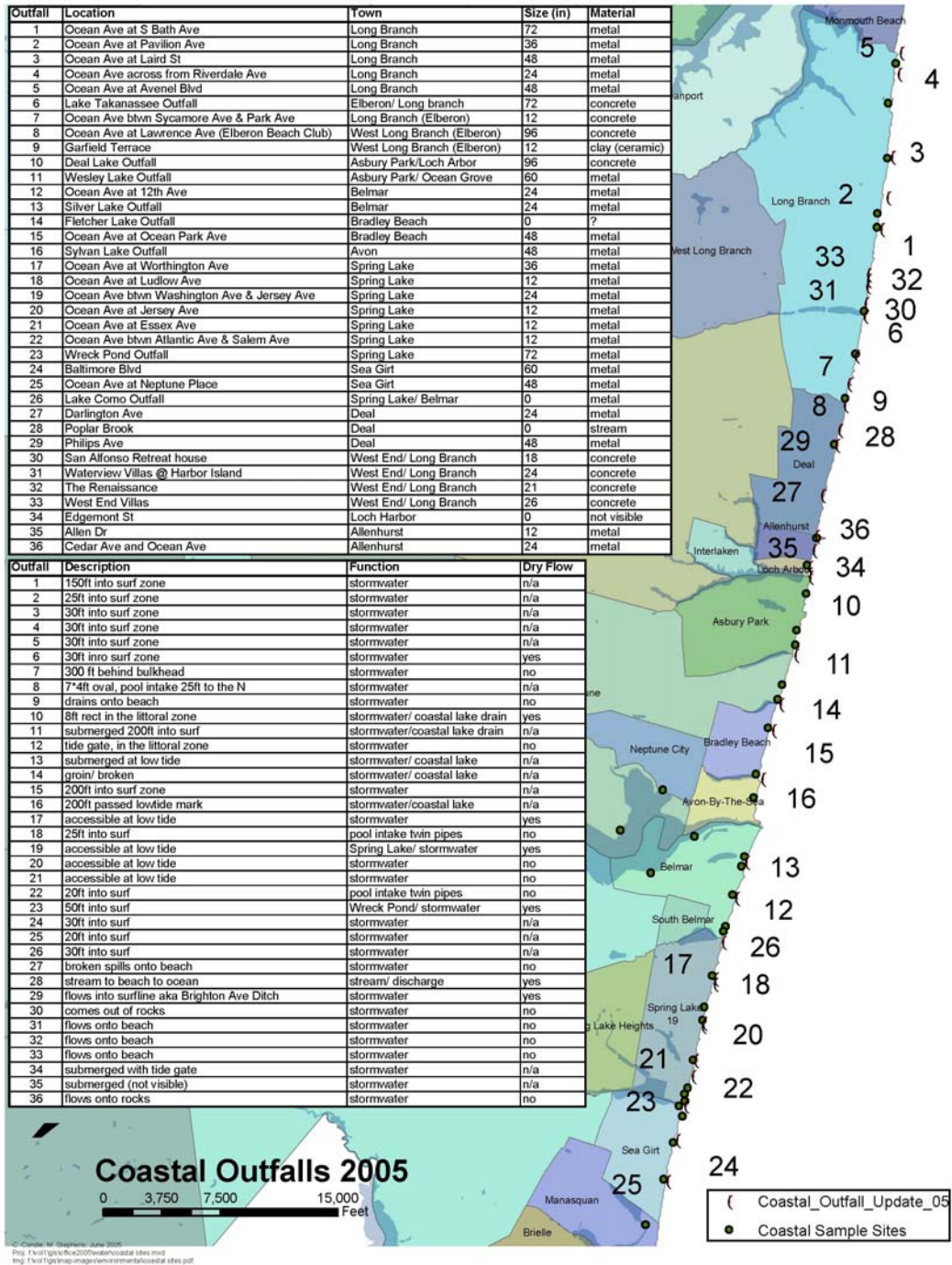
<http://www.saltwatertides.com/cgi-local/newjersey.cgi>

## USGS STREAM GAGE RARITAN RIVER AT BOUND BROOK



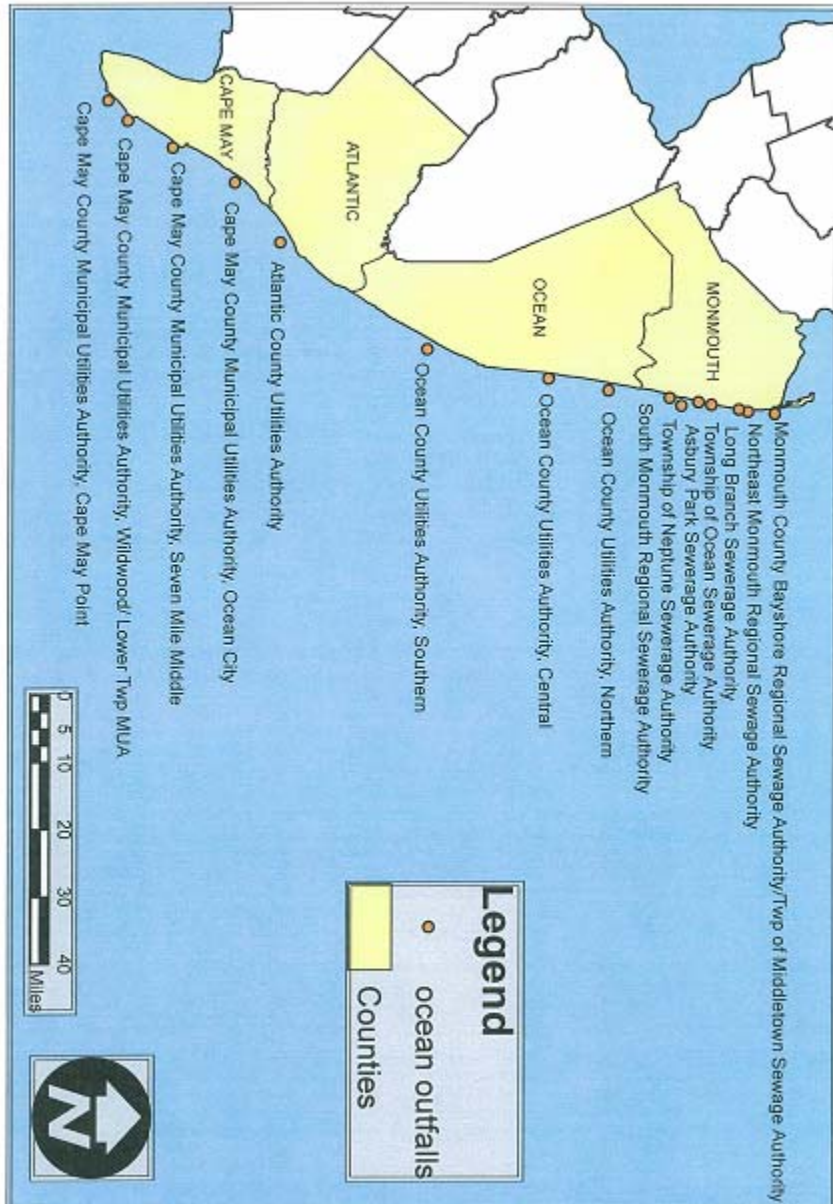
[http://waterdata.usgs.gov/nwisweb/graph?agency\\_cd=USGS&site\\_no=01403060&parm\\_cd=00060&period=60](http://waterdata.usgs.gov/nwisweb/graph?agency_cd=USGS&site_no=01403060&parm_cd=00060&period=60)

# MONMOUTH STORM OUTFALLS



## SEWER OUTFALLS

### Appendix 1 Wastewater Treatment Facilities Discharging to the Nearshore Coastal Waters



<http://www.nj.gov/dep/wms/bmw/bathingbeach/reports/2009ccmp.pdf>