The U.S. Army Corps of Engineers
New York District

The Atlantic Coast of New Jersey
Regional Sediment Budget
1986 - 2003
Manasquan Inlet to Sea Bright

Draft Report
April 2006

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Introduction

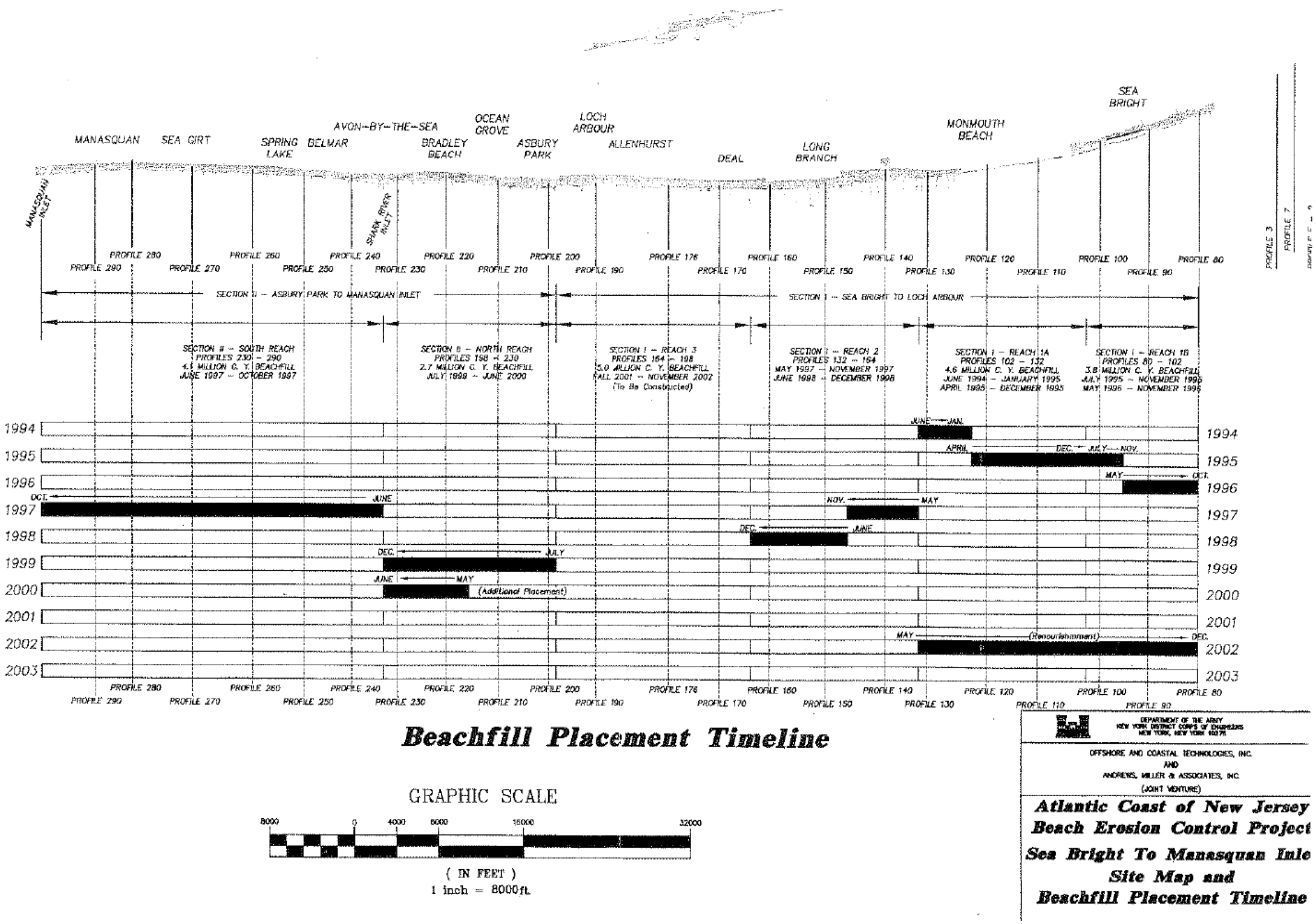
The U.S. Army Corps of Engineers, New York District as part of the New Jersey Alternative Long-Term Nourishment Study (NJALTN) study developed a regional sediment budget from Manasquan Inlet to Sandy Hook. The study area is approximately 21 miles in length, encompasses two inlets, mainland beaches from Manasquan Inlet to Long Branch, and a barrier-spit landform from Long Branch to Sandy Hook. This sediment budget is coupled with the sediment budget from Cape May Point to Manasquan Inlet developed by Philadelphia District to form a single regional sediment budget for the entire Atlantic Ocean coastline of New Jersey. The regional sediment budget covering the Atlantic coast of New Jersey can be a potential tool to help solve local sediment-related problems by designing the most cost effective solutions that take into account a regional strategy.

The Federal Government originally authorized the Atlantic Coast of New Jersey – Sandy Hook to Barnegat Inlet project in 1958. The project objective was to provide beach restoration and storm damage protection to the communities and infrastructure along the study area shoreline. Prior to construction, the study area shoreline was in a sediment-starved condition, and some of the large stone seawall segments were in danger of failing. Construction of the project began in 1994, and consisted of offshore sand placed in a configuration of a 100’ foot wide berm at elevation +10 ft. above MLW (elevation +8.4 ft. NGVD, plus a 2 foot berm cap to +10.4 ft. NGVD), and also provides for periodic nourishment (on an approximate 6-year cycle) over the project life of 50 years. Figure 1 shows the project shoreline. Figure 2 provides the fill history and the construction reach delineations.

A monitoring program for the project has been ongoing, with baseline pre-fill shoreline data of 1986 and 1992, and post-fill data from 1996 to the present. Several historic sediment budgets have been prepared for the project area, including those developed for the without-project conditions. To date, no sediment budget has analyzed the with-project condition. The work described herein is the result of efforts to prepare such a with-project sediment budget. A with-project sediment budget can be a useful tool in investigating observed coastal changes and estimating future changes and management alternatives, but is crucial to aid the understanding of how the shoreline performs in a sediment rich condition, which is especially important since the previous budgets cover sediment-starved conditions.

Figure 1

Figure 2


MANASQUAN INLET
MANASQUAN
SEA GIRT
SPRING LAKE
BELMAR
AVON-BY-THE-SEA
SHARK RIVER INLET
BRADLEY BEACH
OCEAN GROVE
ASBURY PARK
LOCH ARBOUR
ALLENHURST
DEAL
LONG BRANCH
MONMOUTH BEACH
SEA BRIGHT
PROFILE 3
PROFILE 7
PROFILE 290
PROFILE 280
PROFILE 270
PROFILE 260
PROFILE 250
PROFILE 240
PROFILE 230
PROFILE 220
PROFILE 210
PROFILE 200
PROFILE 190
PROFILE 176
PROFILE 170
PROFILE 160
PROFILE 150
PROFILE 140
PROFILE 130
PROFILE 120
PROFILE 110
PROFILE 100
PROFILE 90
PROFILE 80
SECTION II – ASBURY PARK TO MANASQUAN INLET
SECTION I – SEA BRIGHT TO LOCH ARBOUR
SECTION II – SOUTH REACH PROFILES 230 – 290 4.1 MILLION C. Y. BEACHFILL JUNE 1997 – OCTOBER 1997
SECTION II – NORTH REACH PROFILES 198 – 230 2.7 MILLION C. Y. BEACHFILL JULY 1999 – JUNE 2000
SECTION I – REACH 3 PROFILES 164 – 198 5.0 MILLION C. Y. BEACHFILL FALL 2001 – NOVEMBER 2002 (To Be Constructed)
SECTION I – REACH 2 PROFILES 132 – 164 MAY 1997 – NOVEMBER 1997 JUNE 1998 – DECEMBER 1998
SECTION I – REACH 1A PROFILES 102 – 132 4.6 MILLION C. Y. BEACHFILL JUNE 1994 – JANUARY 1995 APRIL 1995 – DECEMBER 1995
SECTION I – REACH 1B PROFILES 80 – 102 3.8 MILLION C. Y. BEACHFILL JULY 1995 – NOVEMBER 1995 MAY 1996 – NOVEMBER 1996
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
JUNE – JAN.
APRIL – DEC.
JULY – NOV.
MAY – OCT.
OCT. – JUNE
NOV. – MAY
DEC. – JUNE
DEC. – JULY
JUNE – MAY
(Additional Placement)
MAY – (Renourishment) – DEC.
Beachfill Placement Timeline
GRAPHIC SCALE
8000
0
4000
8000
16000
32000
(IN FEET)
1 inch = 8000ft.
DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
NEW YORK, NEW YORK 10278
OFFSHORE AND COASTAL TECHNOLOGIES, INC.
AND
ANDREWS, MILLER & ASSOCIATES, INC.
(JOINT VENTURE)
Atlantic Coast of New Jersey
Beach Erosion Control Project
Sea Bright To Manasquan Inle
Site Map and
Beachfill Placement Timeline

Available Data

The following data was available for the project area, collected (by USACE, except where noted).

- Aerial Photographs: Feb. 1992, Apr. 1996, May 1998, Apr. 1999, Apr. 2000, Apr. 2001, Apr. 2002, May 2003.

- Digital Shorelines (from Manasquan Inlet to Seabright): Jun. 1986, Feb. 1992, April 1996, May 1998, April 1999, April 2000, April 2001, April 2002, May 2003 (details about the digitization are contained in the project Monitoring reports).

- Beach Width Data south of Sandy Hook Critical Zone: 1992, 1996, 1997, 1998, 1999, and 2000.

- National Park Service Beach Width Data in Sandy Hook Critical Zone: 1992, 1996, 1997, 1998, 1999, and 2000.

- Profile Data: Apr. 1986, Oct. 1996, Apr. 1997, Sept. 1997, Apr. 1998, Oct. 1998, Mar. 1999, Sept. 1999

- Long Branch Directional Wave Gage Data (NJ001): Nov. 1991-Aug. 1992, Oct. 1992-Dec. 1992, Apr. 1993-Nov. 1994, Jul. 1995-Nov. 1996, Feb. 1997-Mar. 2000, Aug. 2001-Dec. 2001, Apr. 2003-Oct. 2003 (gage removed in Nov. 2003). There are other data gaps of lesser duration. (NDBC Buoy 44025 record utilized during Long Branch Gage gaps).

- WIS Updated Wave Hindcast Data (Stations 126 through 132): 1980-2000 (data from USACE Field Research Facility web site).

- Beachfill Placement Records: Jan.-Jun. 1994, Apr.-Dec. 1995, Jul.-Nov. 1995, May-Oct. 1996, May-Nov. 1997, Jun.-Oct. 1997, Jun.-Dec. 1998, Dec. 1998, Jul.-Dec. 1999, May-Jun. 2000, May-Dec. 2002 (plus State/Local beachfill in 1994)

Periods of Analysis

The periods evaluated included:

- Jun. 1986-Feb. 1992,
- Feb. 1992-Oct. 1996,
- Oct. 1996-Apr. 1998,
- Apr. 1998-Mar. 1999,
- Mar. 1999-May 2000,
- May 2000-Jun. 2001,
- Jun. 2001-Apr. 2002,
- Apr. 2002-Apr. 2003,
- Jun. 1986-Apr. 2003, and
- Feb. 1992-Apr. 2003.

Potential Transport Analysis

Wave data (either collected by a wave gage, or hindcast from collected wind data) can be used to estimate wave energy, which, when used in combination with shoreline orientation angles, can provide an estimate of how much sediment transport could potentially be transported by that wave environment, were there an unlimited supply of sediment. Typically, actual transport rates are lower as sediment available for transport is limited. Both gage data and hindcast data were used to estimate potential transport rates. These results are shown in Tables 1a and 1b. Table 1c shows the hindcast transport rates by periods of analysis. Figure 3 shows the WIS hindcast station locations, and Figure 4 shows the location of the Long Branch Wave Gage NJ001.

Table 1a WIS Waves (1980-1999)

Control Volume	WIS Station #	Shoreline Parallel Azimuth	Potential Longshore Transport Rates (in CY/YR) WIS North Directed	WIS South Directed	WIS Gross	WIS Net	Net
Sandy Hook	126	177	829,000	(162,000)	991,000	667,000	North
Seabright to Long Branch	127	184	1,235,000	(349,000)	1,584,000	886,000	North
Deal	128	193	1,050,000	(581,000)	1,631,000	469,000	North
Asbury Park to Manasquan Inlet	129	194	1,081,000	(816,000)	1,897,000	265,000	North
Manasquan Inlet to Mantaloking	130	195	1,062,000	(896,000)	1,958,000	166,000	North
Mantaloking to Lavalette	131	195	1,160,000	(948,000)	2,108,000	212,000	North
Lavalette to Seaside Park	132	195	1,347,000	(1,291,000)	2,638,000	56,000	North

Table 1b Long Branch Wave Gage (1991-2003)

Control Volume	WIS Station #	Shoreline Parallel Azimuth	Potential Longshore Transport Rates (in CY/YR) Gage North Directed	Gage South Directed	Gage	Gage Net	Net
Long Branch	NJ001	184	1,506,000	(170,000)	1,676,000	1,337,000	North

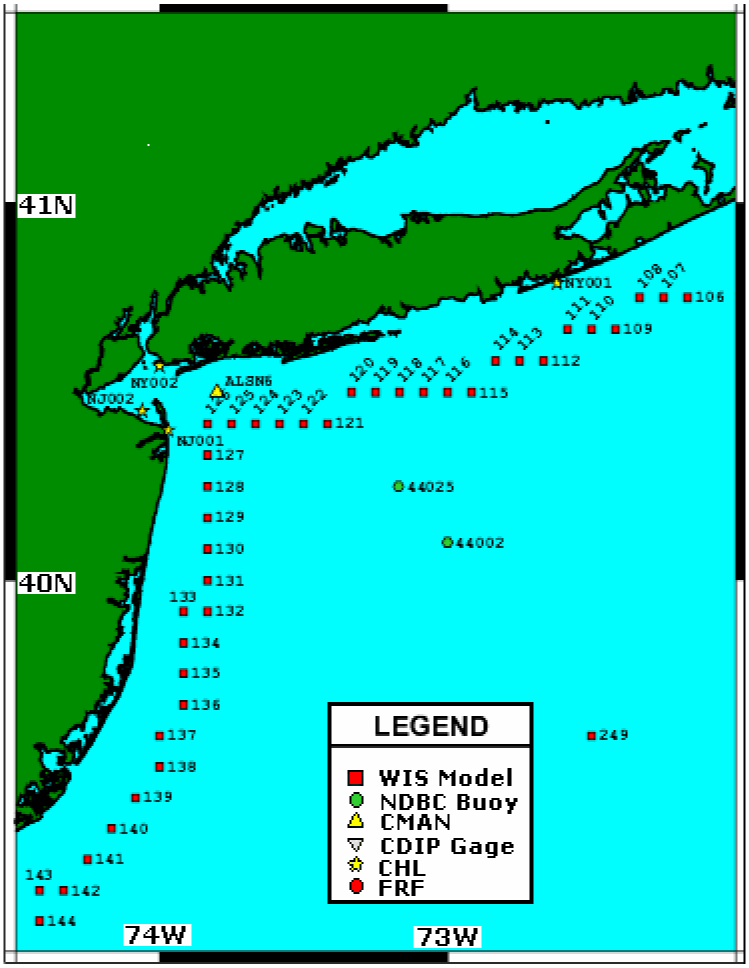


Figure 3

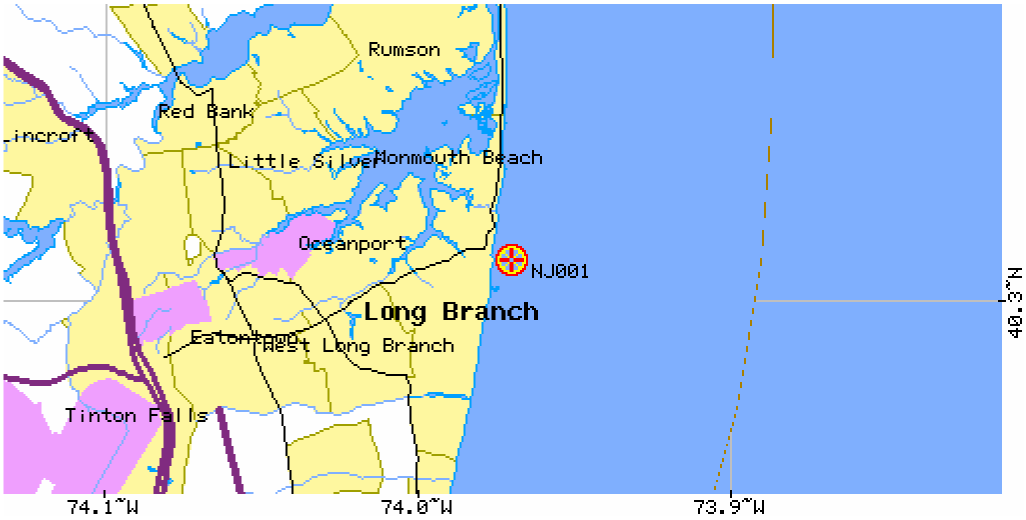


Figure 4

Table 1c WIS Waves by Period of Analysis

			Potential Longshore Transport Rates (in CY/YR)				
Control Volume	WIS Station #	Period	WIS North Directed	WIS South Directed	WIS Gross	WIS Net	Net
Sandy Hook	126	1986-1992	783,000	(145,000)	928,000	638,000	North
Sandy Hook	126	1992-1996	1,249,000	(164,000)	1,413,000	1,085,000	North
Sandy Hook	126	1996-1998	1,185,000	(188,000)	1,373,000	997,000	North
Sandy Hook	126	1998-1999	1,035,000	(232,000)	1,267,000	803,000	North
Sandy Hook	126	1986-1999	948,000	(157,000)	1,105,000	791,000	North
Sandy Hook	126	1992-1999	1,135,000	(167,000)	1,302,000	968,000	North
Seabright to Long Branch	127	1986-1992	711,000	(290,000)	1,001,000	421,000	North
Seabright to Long Branch	127	1992-1996	1,058,000	(353,000)	1,411,000	705,000	North
Seabright to Long Branch	127	1996-1998	1,015,000	(383,000)	1,398,000	632,000	North
Seabright to Long Branch	127	1998-1999	877,000	(457,000)	1,334,000	420,000	North
Seabright to Long Branch	127	1986-1999	738,000	(320,000)	1,058,000	418,000	North
Seabright to Long Branch	127	1992-1999	952,000	(354,000)	1,306,000	598,000	North
Deal	128	1986-1992	691,000	(407,000)	1,098,000	284,000	North
Deal	128	1992-1996	1,106,000	(523,000)	1,629,000	583,000	North
Deal	128	1996-1998	1,006,000	(527,000)	1,533,000	479,000	North
Deal	128	1998-1999	876,000	(640,000)	1,516,000	236,000	North
Deal	128	1986-1999	895,000	(501,000)	1,396,000	394,000	North
Deal	128	1992-1999	999,000	(519,000)	1,518,000	480,000	North
Asbury Park to Manasquan Inlet	129	1986-1992	740,000	(556,000)	1,296,000	184,000	North
Asbury Park to Manasquan Inlet	129	1992-1996	1,102,000	(713,000)	1,815,000	389,000	North
Asbury Park to Manasquan Inlet	129	1996-1998	1,068,000	(726,000)	1,794,000	342,000	North
Asbury Park to Manasquan Inlet	129	1998-1999	948,000	(908,000)	1,856,000	40,000	North
Asbury Park to Manasquan Inlet	129	1986-1999	850,000	(638,000)	1,488,000	212,000	North
Asbury Park to Manasquan Inlet	129	1992-1999	1,128,000	(718,000)	1,846,000	410,000	North
Manasquan Inlet to Mantaloking	130	1986-1992	716,000	(666,000)	1,382,000	50,000	North
Manasquan Inlet to Mantaloking	130	1992-1996	1,093,000	(860,000)	1,953,000	233,000	North
Manasquan Inlet to Mantaloking	130	1996-1998	1,059,000	(884,000)	1,943,000	175,000	North
Manasquan Inlet to Mantaloking	130	1998-1999	991,000	(1,050,000)	2,041,000	(59,000)	North
Manasquan Inlet to Mantaloking	130	1986-1999	840,000	(766,000)	1,606,000	74,000	North
Manasquan Inlet to Mantaloking	130	1992-1999	994,000	(859,000)	1,853,000	135,000	North

Control Volume Development

The study area of was divided into seven control volumes (Table 2), correlating with the beachfill construction contracts.

Table 2

ID	Control Volume Name	Location
7	Sandy Hook	Sandy Hook
6	Section I-Reach 1B	Seabright
5	Section I-Reach 1A	Monmouth Beach
4	Section I-Reach 2	Long Branch
3	Section I-Reach 3	Deal
2	Section II-North Reach	Shark River Inlet to Asbury Park
1	Section II-South Reach	Manasquan Inlet to Shark River Inlet

Beachfill Placement History

The fill placement history broken down by control volume is shown in Table 3a and 3b. Table 3c shows the beachfill placement rates in cubic yards/year. (It should be noted that typically sediment budgets report transport rates in volumes per year, thus allowing comparison between differing data periods.)

Table 3a

Beach Fills 1986-2003 from Mansquan Inlet to Sea Bright

ID	Fill Volumes (CY)	Federal Beachfill Construction Periods
7	2,889,000	Sept. 1989 - Jan. 1990 (Park Service)
1	70,000	1994 (State)
5	4,600,000	Jun. 1994 - Jan. 1995, Apr. 1995 - Dec. 1995
6	3,800,000	Jul. 1995 - Nov. 1995
4	3,700,000	May 1997 - Nov 1997, Jun 1998 - Dec. 1998
1	4,100,000	Jun. 1997 - Oct. 1997
7	287,000	Dec 1997 - Feb. 1998 (Park Service)
5	600,000	Dec. 1998
2	3,100,000	Jul. 1999 - Dec. 1999
2	225,000	May 2000 - Jun. 2000
5	1,125,000	May 2002 - Oct. 2002
6	750,000	Oct. 2002 - Dec. 2002
7	300,000	Nov. 2002 (Park Service)

Table 3b

Beach Fills 1986-2003 from Mansquan Inlet to Sea Bright in cy

from	Jun-86	Jun-86	Feb-92	Oct-96	Apr-98	Mar-99	May-00	Jun-01	Apr-02	Jun-86	Feb-92
to	Feb-92	Oct-96	Oct-96	Apr-98	Mar-99	May-00	Jun-01	Apr-02	Apr-03	Apr-03	Apr-03
years	5.67	10.33	4.67	1.50	0.92	1.17	1.08	0.83	1.00	16.83	11.17
Cell 7	2,889,000	2,889,000	-	287,000	-	-	-	-	300,000	3,476,000	3,476,000
Cell 6	-	3,800,000	3,800,000	-	-	-	-	-	750,000	4,550,000	4,550,000
Cell 5	-	4,600,000	4,600,000	-	600,000	-	-	-	1,125,000	6,325,000	6,325,000
Cell 4	-	-	-	1,850,000	1,850,000	-	-	-	-	3,700,000	3,700,000
Cell 3	-	-	-	-	-	-	-	-	-	-	-
Cell 2	-	-	-	-	-	3,100,000	225,000	-	-	3,325,000	3,325,000
Cell 1	-	70,000	70,000	4,100,000	-	-	-	-	-	4,170,000	4,170,000
Total	2,889,000	11,359,000	8,470,000	6,237,000	2,450,000	3,100,000	225,000	-	2,175,000	25,546,000	25,546,000

Table 3c

Beach Fills 1986-2003 from Mansquan Inlet to Sea Bright in cy/yr

from	Jun-86	Jun-86	Feb-92	Oct-96	Apr-98	Mar-99	May-00	Jun-01	Apr-02	Jun-86	Feb-92
to	Feb-92	Oct-96	Oct-96	Apr-98	Mar-99	May-00	Jun-01	Apr-02	Apr-03	Apr-03	Apr-03
years											
Cell 7	510,000	280,000	-	191,000	-	-	-	-	300,000	206,000	311,000
Cell 6	-	368,000	814,000	-	-	-	-	-	750,000	270,000	407,000
Cell 5	-	445,000	986,000	-	655,000	-	-	-	1,125,000	376,000	566,000
Cell 4	-	-	-	1,233,000	2,018,000	-	-	-	-	220,000	331,000
Cell 3	-	-	-	-	-	-	-	-	-	-	-
Cell 2	-	-	-	-	-	2,657,000	208,000	-	-	198,000	298,000
Cell 1	-	7,000	15,000	2,733,000	-	-	-	-	-	248,000	373,000

Volumetric Change Methodology

Two methods currently exist to estimate large-scale volumetric changes along a shoreline: profile comparisons and shoreline comparisons. Each has drawbacks. Profile data is two-dimensional in offshore shape, and can capture bar development, or any other cross-shore shape change; however, profile data is typically sparse, (one profile per MILE of beach for this project). So the longshore changes (i.e., groin trapping, hot spots, undulations) are not able to be included. Furthermore, the data sparcity can misrepresent changes by assuming that the volume change measured in the ONE profile represents the volume changes over the entire mile (in our case). For instance, suppose one profile had a large bar formation that happened to be localized; this accretion would be assumed to occur over one mile, potentially giving the erroneous impression that the entire mile experienced like accretion, whereas, in fact, the opposite may be true. Conversely, suppose the one profile happened to be located in the middle of a hot spot; the volumetric changes would reflect one mile of severe erosion, whereas the other 9/10ths of the mile may have experienced significant accretion.

For shoreline-based volumetric change estimation, currently technology allows only straight translation assumptions in shoreline change comparison, which assumes the beach face moves in a perfectly parallel manner, whereby offshore bar development and scarp formation are not able to be included. Typically, shoreline data is digitized into an x, y stream of data, then the data is plotted, and the data analyst visually measures the offset between the shoreline at set intervals; typically on the order of 100 ft.

The method selected for this post-fill sediment budget between Manasquan Inlet and Seabright was shoreline change-based. But a new procedure was incorporated: entering the shoreline data into graphical modeling software, which created 3-dimensional “surfaces” of each shoreline, and having the software calculate the volume change between the two “surfaces”. This allows a much smaller “interval” to be incorporated. The interval is only limited by the data collection density, so if the shoreline data was digitized resulting in data points every 10 feet, all the data is used to develop the volume change (as opposed to the visual method, where the density is limited to about every 100 feet or so. The assumption was still perfect parallel translation in this case, but it is expected that some differences between volume change based on data sampled every 100 feet and volume change based on data sampled every 10 feet (though both of these sets of data should agree in trend, and order of magnitude; unlike comparing profile based volume change which may result in several order of magnitude differences, and changes in trend)

Should the shoreline based graphics software method prove effective and accurate (when compared to other methods), it won’t be long that such software can be innovated to incorporate the best of shoreline change and profile change methods, thus making truly unique 3-D surfaces, accurate in the alongshore AND cross-shore direction; hence drastically advancing sediment budget methodology and accuracy.

The method utilized in the Sandy Hook region involved utilizing comparative beach width data at set locations. The beach widths were measures at approximately MHW. The interval distance between the data locations was on the order of 500 foot, much less dense than the 100 ft spacing available with digital shoreline data. But, based on the limitations of the available data, the shoreline change was estimated using beach width changes at 500 foot spacing for the Sandy Hook region for the period 1992 to 2000. Figure 5 shows the Sandy Hook region included in the sediment budget, and the profile reference marks where beach width was measured.

Representative berm heights and closure depths from available profile data was analyzed to determine an active profile height for each control volume. A maximum berm elevation of +10. NGVD and minimum depth of closure –20 ft. NGVD were determined.

As a comparison, volumetric changes calculated as part of the monitoring study for Manasquan Inlet to Seabright, were evaluated, to check the validity and reasonableness of the 3-dimensional method. The Atlantic Coast of New Jersey Post-Construction Monitoring Data Analysis Report for Sandy Hook to Manasquan Inlet Beach Erosion Control Project, Final Report June 30, 2005 contained volumetric changes for each monitoring beach profile (in cy/lf) and also contained charts of average shoreline change rates for the same periods as listed above. The average shoreline change rates (called Manual Shoreline Change to differentiate it from the “3-D surface” method) for each period were multiplied by the number of years in the period, and by the average active profile height of 30 ft. (+10 ft. NGVD to –20 ft. NGVD) to get resulting volume changes.

As a secondary comparison, the profile changes reported in the monitoring report were converted into volumetric changes for Manasquan Inlet to Sandy Hook (with the understanding that these are ONLY to be used for comparisons, and NOT for estimating purposes, or for design changes-the profiles are spaced too far apart for this data to be used quantitatively!) The profile volume changes reported above 0 ft and –24 ft. NGVD contours were multiplied by effective shoreline lengths to get resulting volume changes for each period. These estimates were used as comparison check of the new 3-D method.

Tables 4a, b, c, and d show the resulting shoreline change volumes in cubic yards between each period for the 3-D surface method, the manual shoreline method, the profile-based changes above 0’ ft. NGVD and the profile-based changes above –24 ft. NGVD, respectively.

Tables 5a, b, c, and d show the change rates in cubic yards/year for the 3-D surface method, the manual shoreline method, the profile-based changes above 0 ft. NGVD, and the profile-based changes above –24 ft. NGVD, respectively.

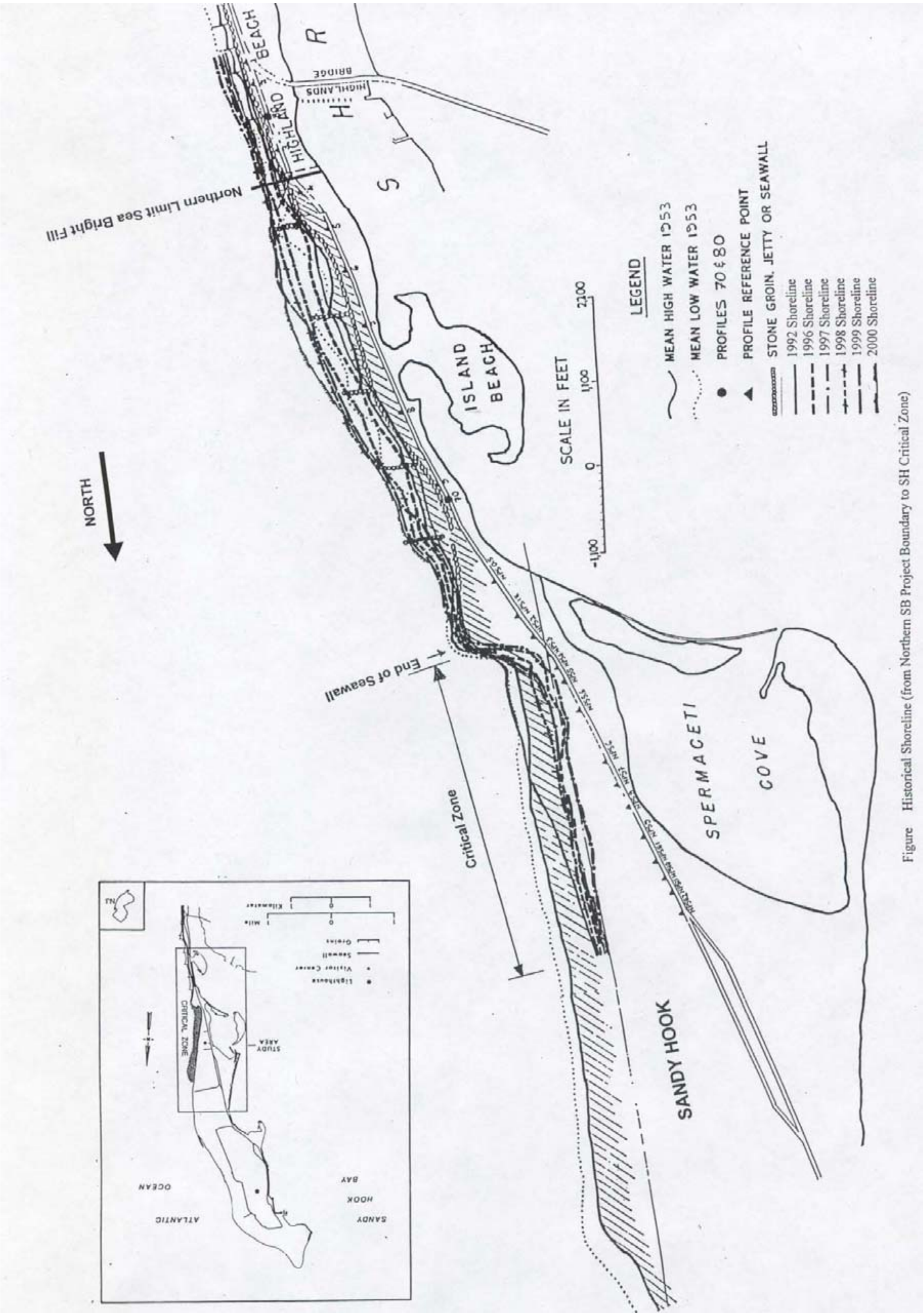


Figure Historical Shoreline (from Northern SB Project Boundary to SH Critical Zone)

Figure 5

Table 4a
"3-D Surface" Shoreline Change Volumes in Cubic Yards

from	**Jun-86**	**Jun-86**	**Feb-92**	**Oct-96**	**Apr-98**	**Mar-99**	**May-00**	**Jun-01**	**Apr-02**	**Jun-86**	**Feb-92**
to	**Feb-92**	**Oct-96**	**Oct-96**	**Apr-98**	**Mar-99**	**May-00**	**Jun-01**	**Apr-02**	**Apr-03**	**Apr-03**	**Apr-03**
(years)	5.67	10.33	4.67	1.50	0.92	1.17	1.08	0.83	1.00	16.83	11.17
Cell 7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cell 6	658,000	2,300,000	1,642,000	2,443,000	(84,000)	72,000	193,000	93,000	508,000	5,525,000	4,867,000
Cell 5	244,000	4,307,000	4,063,000	224,000	(530,000)	570,000	103,000	17,000	326,000	5,017,000	4,773,000
Cell 4	627,000	621,000	(6,000)	1,054,000	3,504,000	(480,000)	(171,000)	(128,000)	(1,513,000)	2,887,000	2,260,000
Cell 3	673,000	701,000	28,000	9,000	244,000	(99,000)	12,000	325,000	(275,000)	917,000	244,000
Cell 2	320,000	235,000	(85,000)	144,000	290,000	2,756,000	119,000	638,000	(874,000)	3,308,000	2,988,000
Cell 1	(199,000)	10,000	209,000	2,943,000	731,000	(175,000)	3,000	497,000	(788,000)	3,221,000	3,420,000
Total	**2,323,000**	**8,174,000**	**5,851,000**	**6,817,000**	**4,155,000**	**2,644,000**	**259,000**	**1,442,000**	**(2,616,000)**	**20,875,000**	**18,552,000**

Table 4b
Manual Shoreline Change Volumes in Cubic Yards

from	**Jun-86**	**Jun-86**	**Feb-92**	**Oct-96**	**Apr-98**	**Mar-99**	**May-00**	**Jun-01**	**Apr-02**	**Jun-86**	**Feb-92**	**Feb-92**
to	**Feb-92**	**Oct-96**	**Oct-96**	**Apr-98**	**Mar-99**	**May-00**	**Jun-01**	**Apr-02**	**Apr-03**	**Apr-03**	**Apr-03**	**May-00**
(years)	5.67	10.33	4.67	1.50	0.92	1.17	1.08	0.83	1.00	16.83	11.17	8.25
Cell 7	n/a	n/a	(694,038)	1,681,789	(130,067)	243,300	n/a	n/a	n/a	n/a	n/a	1,100,984
Cell 6	n/a	n/a	716,000	2,906,000	40,000	131,000	33,000	165,000	293,000	n/a	4,284,000	
Cell 5	n/a	n/a	4,724,000	(288,000)	(681,000)	478,000	197,000	(34,000)	750,000	n/a	5,146,000	
Cell 4	n/a	n/a	172,000	1,567,000	3,648,000	(460,000)	(90,000)	(182,000)	(1,756,000)	n/a	2,899,000	
Cell 3	n/a	n/a	(28,000)	46,000	205,000	(118,000)	349,000	426,000	(334,000)	n/a	546,000	
Cell 2	n/a	n/a	(55,000)	92,000	223,000	2,577,000	337,000	262,000	(767,000)	n/a	2,669,000	
Cell 1	n/a	n/a	198,000	3,128,000	601,000	(44,000)	40,000	447,000	(686,000)	n/a	3,684,000	
Total			**5,727,000**	**7,451,000**	**4,036,000**	**2,564,000**	**866,000**	**1,084,000**	**(2,500,000)**		**19,228,000**	

Table 4c
Profile Change Volumes above 0' NGVD in Cubic Yards

from	**Jun-86**	**Apr-86**	**Feb-92**	**Oct-96**	**Apr-98**	**Mar-99**	**Mar-00**	**Apr-01**	**May-02**	**Apr-86**	**Feb-92**
to	**Feb-92**	**Oct-96**	**Oct-96**	**Apr-98**	**Mar-99**	**Mar-00**	**Apr-01**	**May-02**	**Mar-03**	**Mar-03**	**Mar-03**
(years)	5.67	10.50	4.67	1.50	0.92	1.00	1.08	1.08	0.83	16.92	11.08
Cell 7	n/a	n/a	n/a	n/a	3,000	(17,000)	(78,000)	(46,000)	(35,000)	(173,000)	n/a
Cell 6	n/a	20,889,000	n/a	(458,000)	33,000	(29,000)	(787,000)	520,000	398,000	20,566,000	n/a
Cell 5	n/a	13,828,000	n/a	(166,000)	(25,000)	-	58,000	290,000	363,000	14,348,000	n/a
Cell 4	n/a	465,000	n/a	262,000	662,000	(159,000)	(1,519,000)	25,000	19,000	(245,000)	n/a
Cell 3	n/a	(283,000)	n/a	211,000	(161,000)	2,000	580,000	(503,000)	(385,000)	(539,000)	n/a
Cell 2	n/a	835,000	n/a	(63,000)	16,000	1,205,000	8,000	8,000	(62,000)	1,947,000	n/a
Cell 1	n/a	(1,883,000)	n/a	239,000	26,000	(51,000)	173,000	173,000	180,000	(1,143,000)	n/a
Total		**33,851,000**		**25,000**	**551,000**	**968,000**	**(1,487,000)**	**513,000**	**513,000**	**34,934,000**	

Table 4d
Profile Change Volumes above -24' NGVD in Cubic Yards

from	**Jun-86**	**Apr-86**	**Feb-92**	**Oct-96**	**Apr-98**	**Mar-99**	**Mar-00**	**Apr-01**	**May-02**	**Apr-86**	**Feb-92**
to	**Feb-92**	**Oct-96**	**Oct-96**	**Apr-98**	**Mar-99**	**Mar-00**	**Apr-01**	**May-02**	**Mar-03**	**Mar-03**	**Mar-03**
(years)	5.67	10.50	4.67	1.50	0.92	1.00	1.08	1.08	0.83	16.92	11.08
Cell 7	n/a	n/a	n/a	n/a	308,000	(770,000)	(168,000)	(2,000)	(1,000)	n/a	n/a
Cell 6	n/a	50,507,000	n/a	(399,000)	390,000	(313,000)	(1,380,000)	586,000	448,000	49,839,000	n/a
Cell 5	n/a	33,754,000	n/a	79,000	9,000	54,000	(442,000)	711,000	544,000	34,709,000	n/a
Cell 4	n/a	9,000	n/a	729,000	1,484,000	(157,000)	(3,511,000)	17,000	13,000	(1,416,000)	n/a
Cell 3	n/a	1,397,000	n/a	843,000	(451,000)	18,000	1,773,000	(1,018,000)	(778,000)	1,784,000	n/a
Cell 2	n/a	(5,298,000)	n/a	69,000	(18,000)	3,139,000	(28,000)	(28,000)	54,000	(2,110,000)	n/a
Cell 1	n/a	(7,065,000)	n/a	1,615,000	233,000	60,000	124,000	124,000	528,000	(4,381,000)	n/a
Total		**73,304,000**		**2,936,000**	**1,647,000**	**2,801,000**	**(3,464,000)**	**392,000**	**809,000**	**78,425,000**	

Table 5a

"3-D Surface" Shoreline Change Volume Rates in Cubic Yards/Year

from	Jun-86	Jun-86	Feb-92	Oct-96	Apr-98	Mar-99	May-00	Jun-01	Apr-02	Jun-86	Feb-92
to	Feb-92	Oct-96	Oct-96	Apr-98	Mar-99	May-00	Jun-01	Apr-02	Apr-03	Apr-03	Apr-03
Cell #											
7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
6	116,000	223,000	352,000	1,629,000	(92,000)	62,000	178,000	112,000	508,000	328,000	436,000
5	43,000	417,000	871,000	149,000	(578,000)	489,000	95,000	20,000	326,000	298,000	427,000
4	111,000	60,000	(1,000)	703,000	3,823,000	(411,000)	(158,000)	(154,000)	(1,513,000)	172,000	202,000
3	119,000	68,000	6,000	6,000	266,000	(85,000)	11,000	390,000	(275,000)	54,000	22,000
2	56,000	23,000	(18,000)	96,000	316,000	2,362,000	110,000	766,000	(874,000)	197,000	268,000
1	(35,000)	1,000	45,000	1,962,000	797,000	(150,000)	3,000	596,000	(788,000)	191,000	306,000

Table 5b

Manual Shoreline Change Volume Rates in Cubic Yards/Year

from	Jun-86	Apr-86	Feb-92	Oct-96	Apr-98	Mar-99	May-00	Jun-01	Apr-02	Jun-86	Feb-92	Feb-92
to	Feb-92	Oct-96	Oct-96	Apr-98	Mar-99	May-00	Jun-01	Apr-02	Apr-03	Apr-03	Apr-03	May-00
Cell #												
7	n/a	n/a	(149,000)	1,121,000	(142,000)	209,000	n/a	n/a	n/a	n/a	n/a	133,000
6	n/a	n/a	153,000	1,937,000	44,000	112,000	30,000	198,000	293,000	n/a	384,000	
5	n/a	n/a	1,012,000	(192,000)	(743,000)	410,000	182,000	(41,000)	750,000	n/a	461,000	
4	n/a	n/a	37,000	1,045,000	3,980,000	(394,000)	(83,000)	(218,000)	(1,756,000)	n/a	260,000	
3	n/a	n/a	(6,000)	31,000	224,000	(101,000)	322,000	511,000	(334,000)	n/a	49,000	
2	n/a	n/a	(12,000)	61,000	243,000	2,209,000	311,000	314,000	(767,000)	n/a	239,000	
1	n/a	n/a	42,000	2,085,000	656,000	(38,000)	37,000	536,000	(686,000)	n/a	330,000	

Table 5c

Profile Change Volume Rates above 0' NGVD in Cubic Yards/Year

from	Jun-86	Apr-86	Feb-92	Oct-96	Apr-98	Mar-99	Mar-00	Apr-01	May-02	Apr-86	Feb-92
to	Feb-92	Oct-96	Oct-96	Apr-98	Mar-99	Mar-00	Apr-01	May-02	Mar-03	Mar-03	Mar-03
Cell #											
7	n/a	n/a	n/a	n/a	3,000	(17,000)	(72,000)	(42,000)	(42,000)	n/a	n/a
6	n/a	1,989,000	n/a	(305,000)	36,000	(29,000)	(726,000)	480,000	478,000	1,216,000	n/a
5	n/a	1,317,000	n/a	(111,000)	(27,000)	0	54,000	268,000	436,000	848,000	n/a
4	n/a	44,000	n/a	175,000	722,000	(159,000)	(1,402,000)	23,000	23,000	(14,000)	n/a
3	n/a	(27,000)	n/a	141,000	(176,000)	2,000	535,000	(464,000)	(462,000)	(32,000)	n/a
2	n/a	80,000	n/a	(42,000)	17,000	1,205,000	7,000	7,000	(74,000)	115,000	n/a
1	n/a	(179,000)	n/a	159,000	28,000	(51,000)	160,000	160,000	216,000	(68,000)	n/a

Table 5d

Profile Change Volume Rates above -24' NGVD in Cubic Yards/Year

from	Jun-86	Jun-86	Feb-92	Oct-96	Apr-98	Mar-99	Mar-00	Apr-01	May-02	Jun-86	Feb-92
to	Feb-92	Oct-96	Oct-96	Apr-98	Mar-99	Mar-00	Apr-01	May-02	Mar-03	Mar-03	Mar-03
Cell #											
7	n/a	n/a	n/a	n/a	336,000	(770,000)	(155,000)	(2,000)	(1,000)	n/a	n/a
6	n/a	4,810,000	n/a	(266,000)	425,000	(313,000)	(1,274,000)	541,000	538,000	2,946,000	n/a
5	n/a	3,215,000	n/a	53,000	10,000	54,000	(408,000)	656,000	653,000	2,052,000	n/a
4	n/a	1,000	n/a	486,000	1,619,000	(157,000)	(3,241,000)	16,000	16,000	(84,000)	n/a
3	n/a	133,000	n/a	562,000	(492,000)	18,000	1,637,000	(940,000)	(934,000)	105,000	n/a
2	n/a	(505,000)	n/a	46,000	(20,000)	3,139,000	(26,000)	(26,000)	65,000	(125,000)	n/a
1	n/a	(673,000)	n/a	1,077,000	254,000	60,000	114,000	114,000	634,000	(259,000)	n/a

Discussion of Volumetric Change Rate Differences

Figures 6 through 15 show the comparisons for each period of analysis (1986-1996, 1992-1996, 1996-1998, 1998-1999, 1999-2000, 2000-2001, 2001-2002, 2002-2003, 1986-2003, and 1992-2003, respectively). Data is discussed by period below.

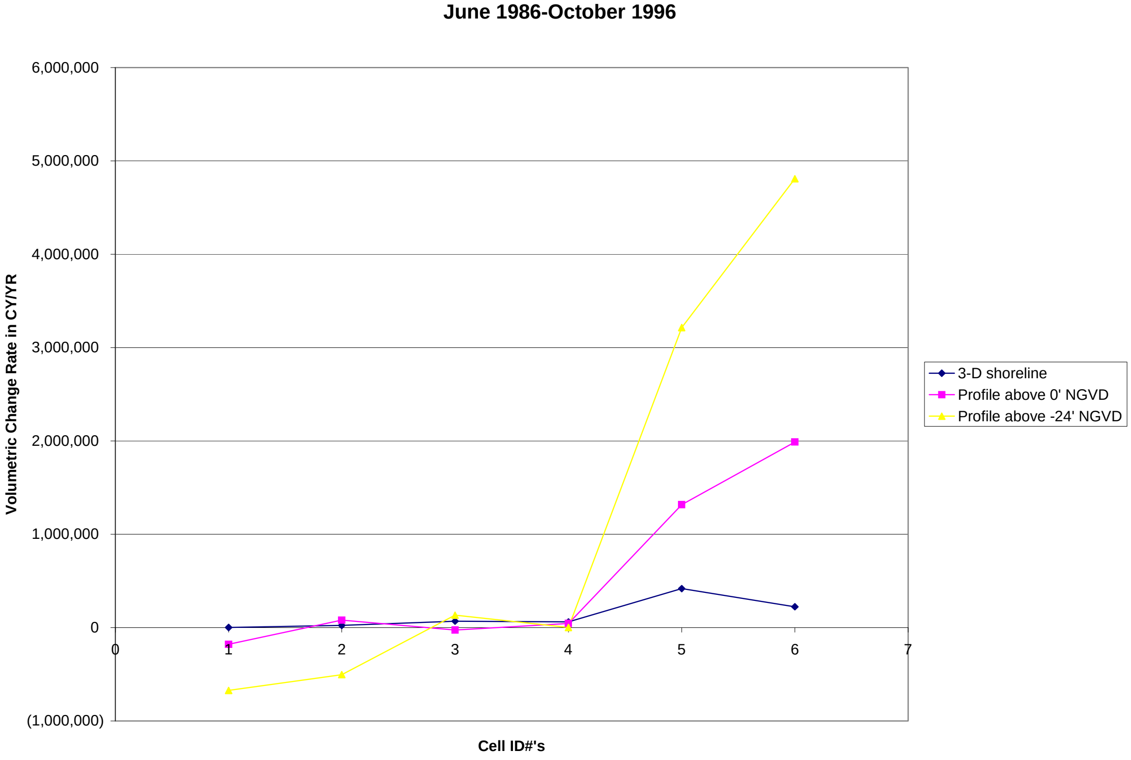


Figure 6

- 1986-1996 (Figure 6). The profile volume changes here seem overestimated in Cells 5 and 6 (Sea Bright and Monmouth Beach). Perhaps the profile extrapolated a localized accretion over a few miles.

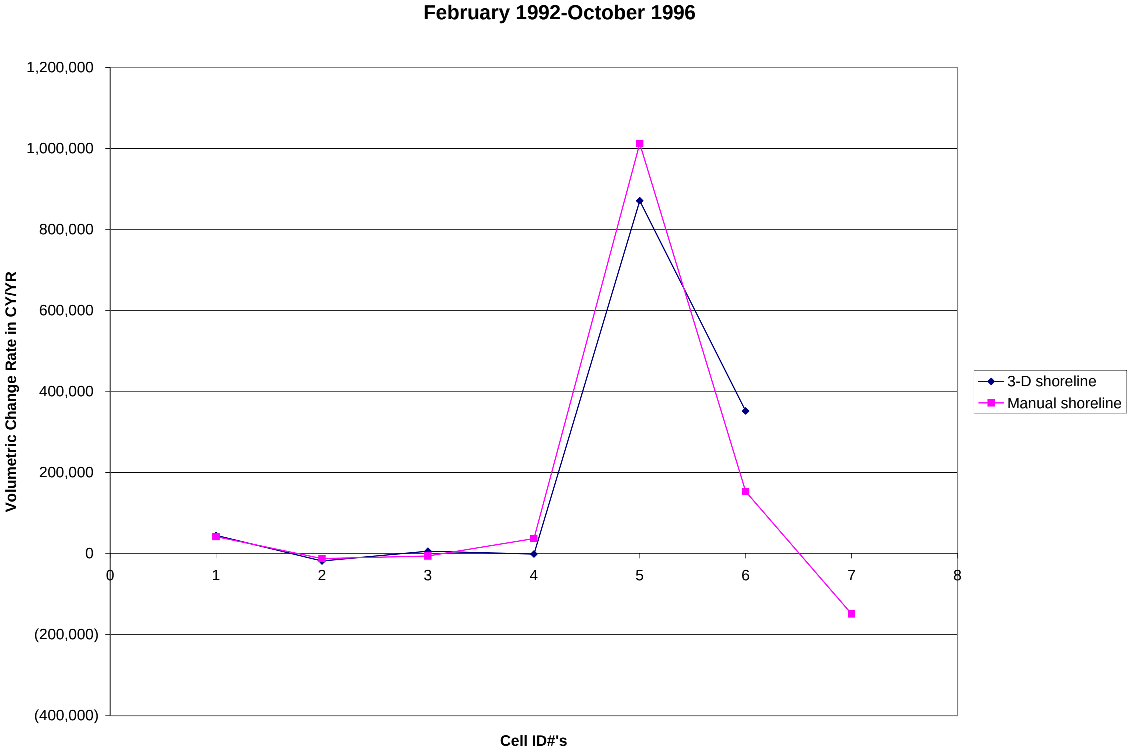


Figure 7

- 1992-1996 (Figure 7). No profile data exists for this time period, but the 3-D and manual shoreline change rates are very close.

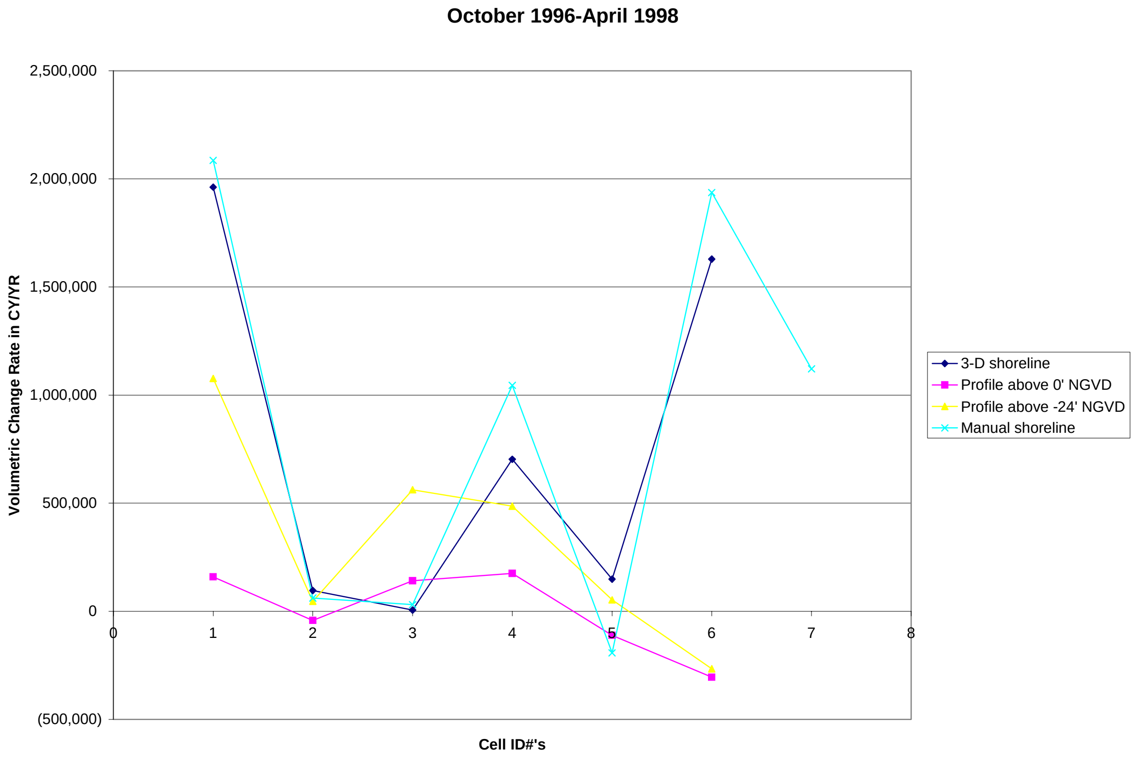


Figure 8

- 1996-1998 (Figure 8). Here again in cells 5 and 6, the profile changes vary greatly from shoreline ones. Perhaps a localized erosion spot at the profile location got extrapolated over a few miles. The shoreline values are close.

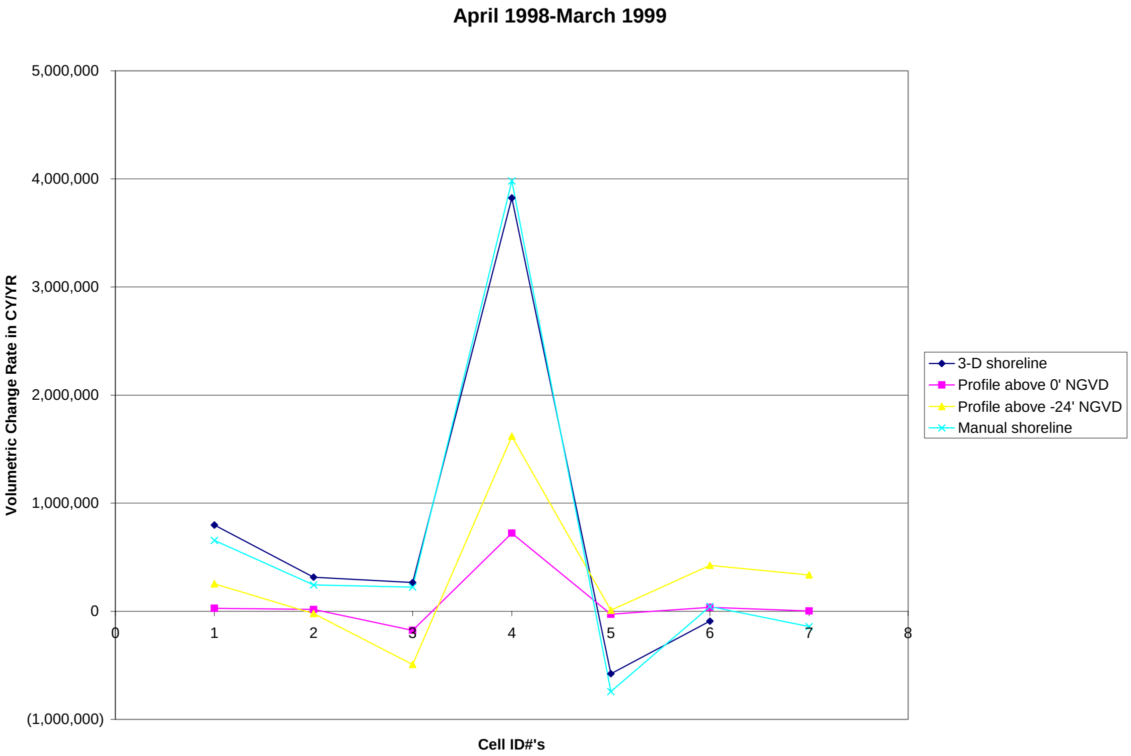


Figure 9

- 1998-1999 (Figure 9). Aside for an anomaly in cell 2 for the profile changes above –24 ‘ NGVD, the trend is similar in all data sets, and the magnitude of the shoreline changes is close.

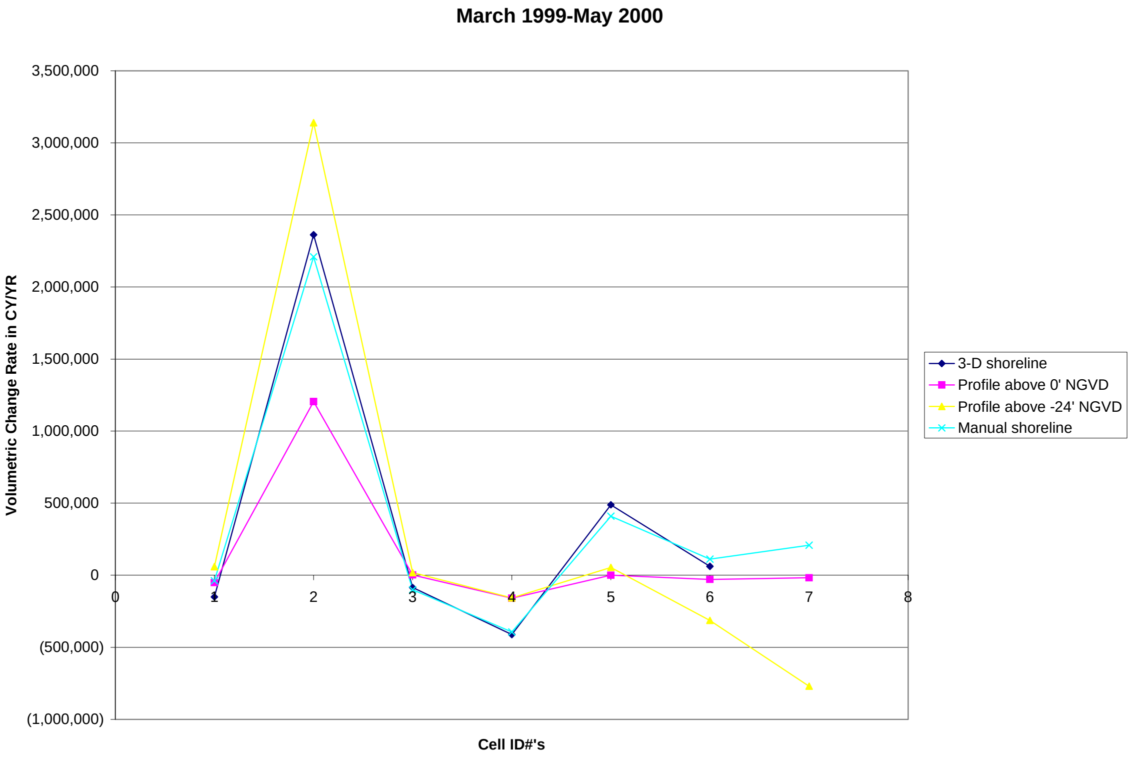


Figure 10

- 1999-2000 (Figure 10). Here the trend is predicted by all 4 data sets, and the magnitude of the shoreline data sets is close.

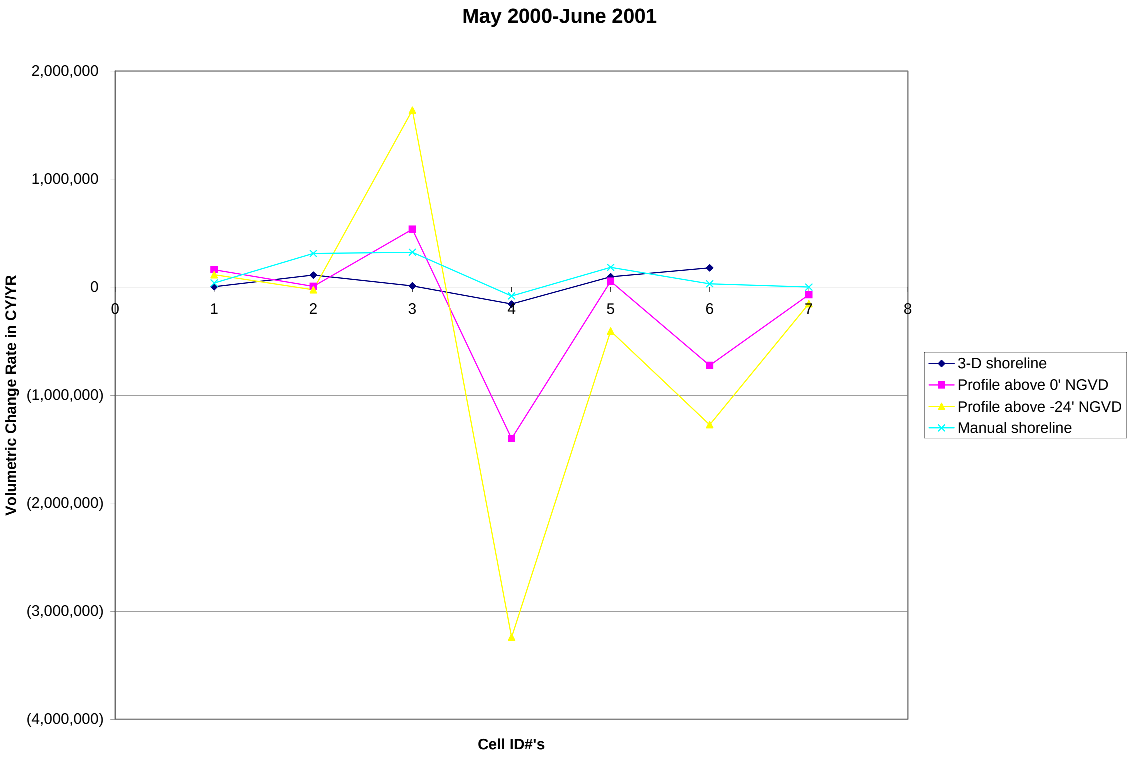


Figure 11

- 2000-2001 (Figure 11). Here the magnitude of the profile changes is much higher than those of the shoreline ones, in most cells. But again, the shoreline data sets are very close.

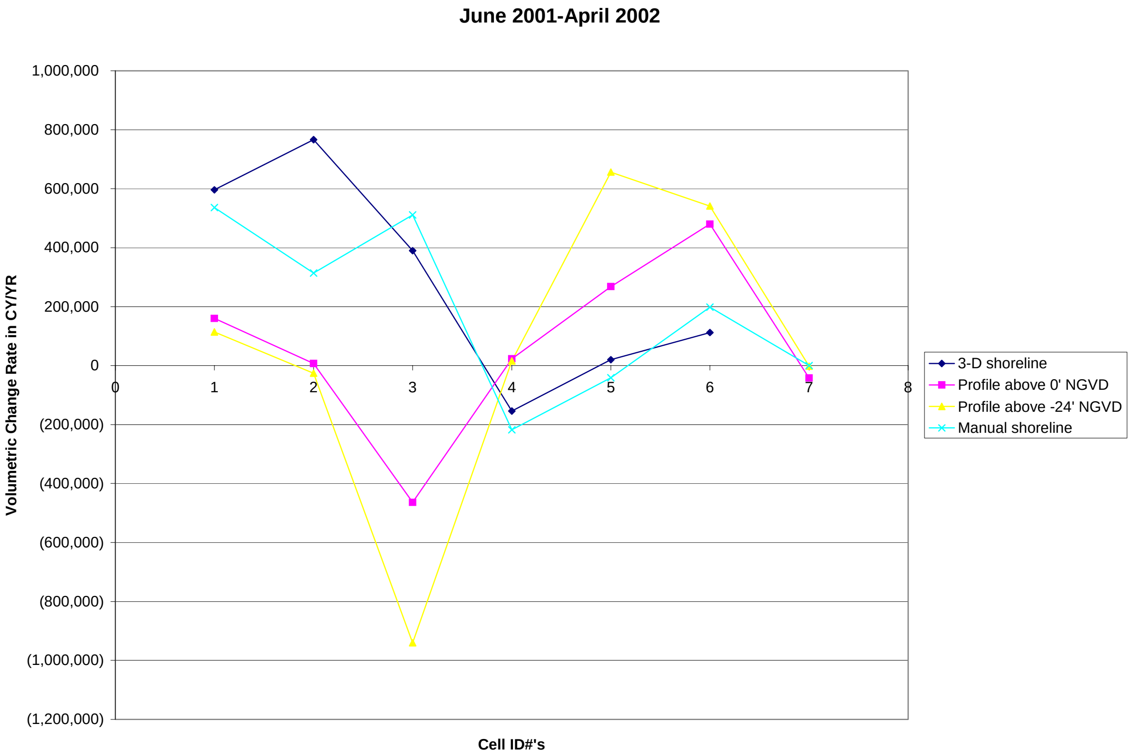


Figure 12

- 2001-2002 (Figure 12). Same as pervious period, except here, the shoreline data sets differ at cell 2 (Asbury North). The trend is close, however. The 3-D shoreline predicts double the amount of accretion in cell 2 as the manual shoreline. Looking at the shoreline change data for this period in the monitoring report, there appears to be no set trend of accretion or erosion. Data divergence may be due to localized effects not being captured in the data density for the manual shoreline.

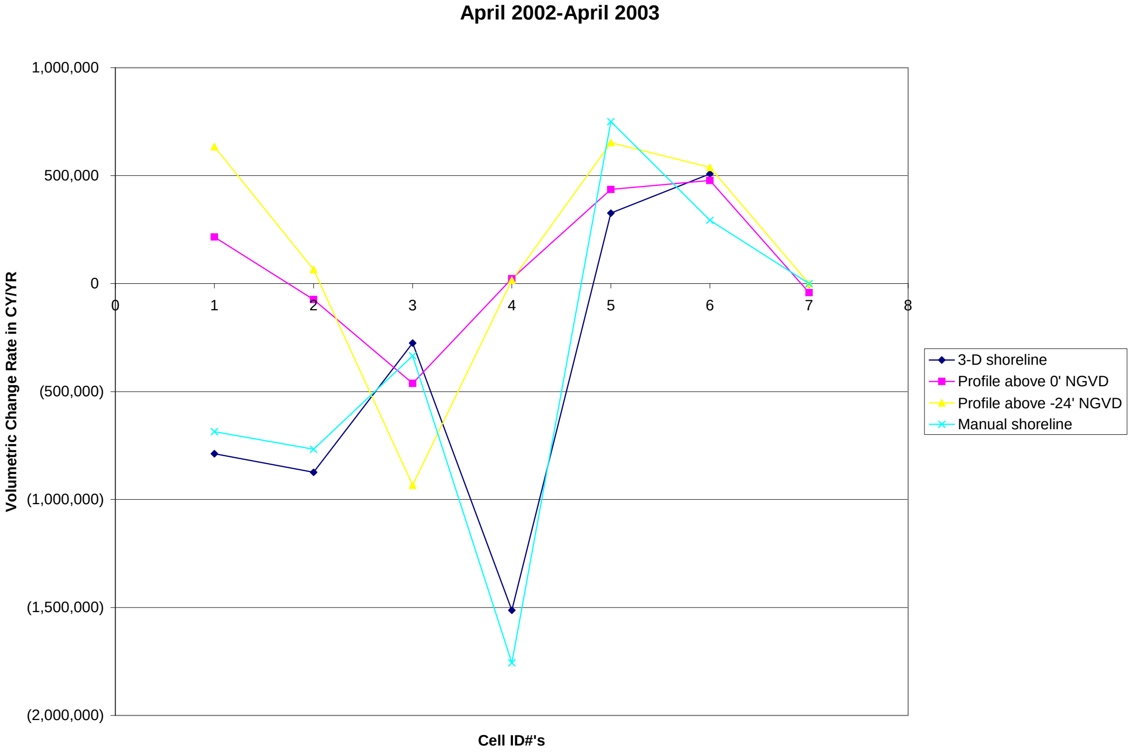


Figure 13

- 2002-2003 (Figure 13). Here the data trends of cells 5 and 6 are close for all 4 data sets, but for the rest of the cells, the profile changes contradict the shoreline changes. But the shoreline data sets match well, except at cell 2, whereby the manual shoreline predicts double the amount of accretion as the 3-D method.

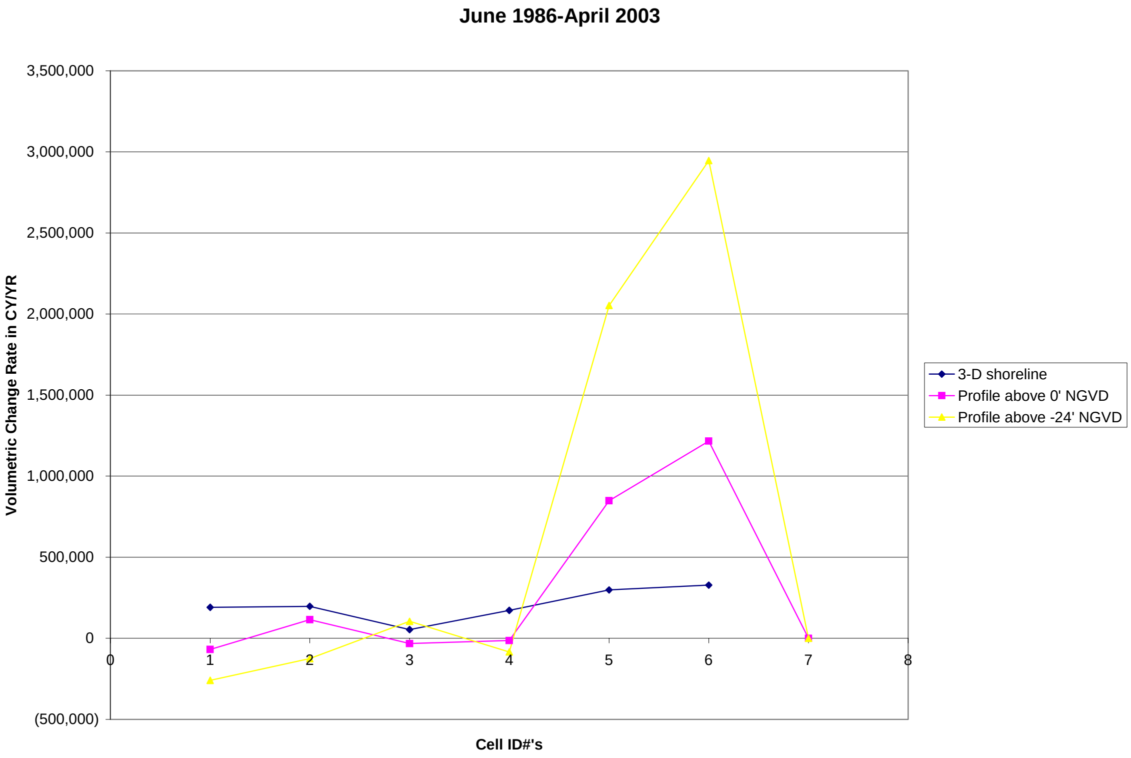


Figure 14

- 1986-2003 (Figure 14). There was no manual shoreline for this period. The overestimated profile change discrepancy from the 1986-1996 period shows up in cells 5 and 6 here.

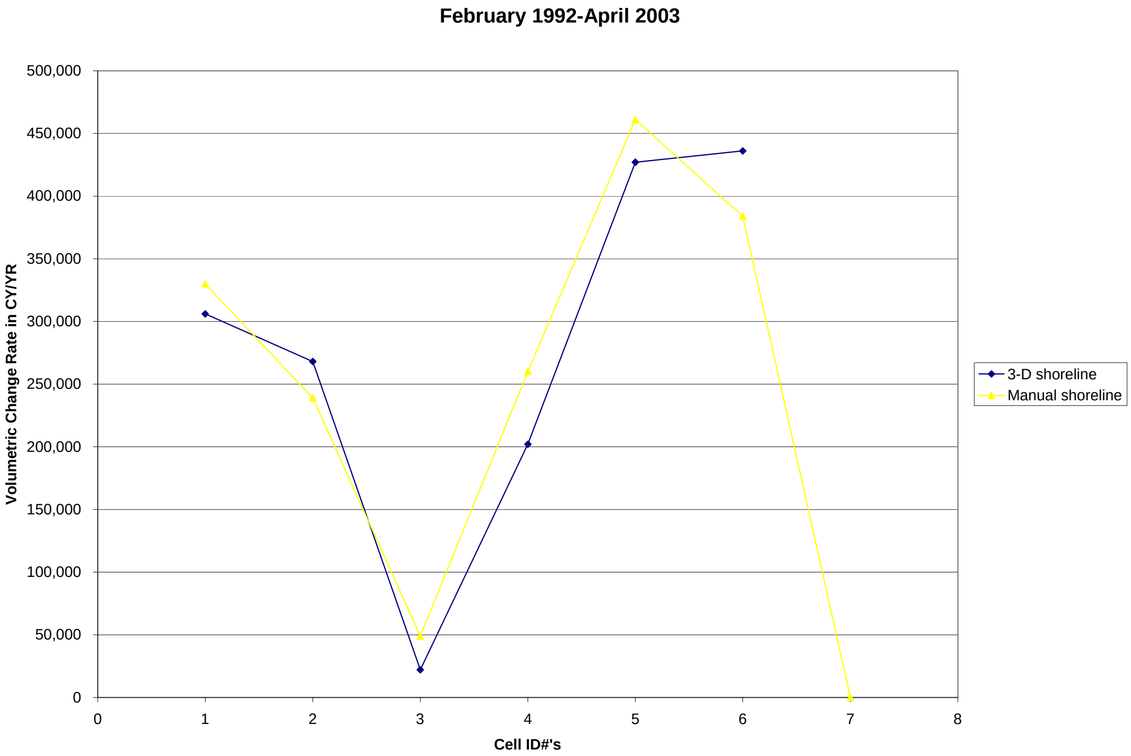


Figure 15

- 1992-2003 (Figure 15). There was no profile data for this period. The 3-D and manual shoreline data are virtually identical.

Longshore Transport Rates at Manasquan Inlet

The general transport direction for the shoreline north of Manasquan Inlet is north. There is transport south bound during periods, but overall the net transport is typically to the north. Therefore the transport across Manasquan Inlet is the starting value. All other values will be computed based upon the Manasquan Inlet transport. Caldwell (1966) estimated a longshore transport rate at Manasquan Inlet of 57,000 cm/yr (75,000 cy/yr) to the north, and CHL (1989) estimated a longshore transport rate at Manasquan Inlet of 102,000 cm/yr (133,000 cy/yr) (see Figure 16). For this present study, potential transport rates computed using WIS hindcast data for each period of analysis (e.g., a potential transport rate was computed for 1986-1992, 1992-1996, etc.) for Station 130 were assumed representative of Manasquan Inlet conditions. Table 6 shows the resulting longshore transport rates assumed to enter the southern boundary of the Cell 1 control volume.

Table 6
Longshore Transport Rates Offshore of Manasquan Inlet*

From	To	Longshore Transport Rate** cy/yr	Direction	
1986	1992	50,000	North	
1992	1996	233,000	North	
1996	1998	175,000	North	
1998	1999	(59,000)	South	
1986	1999	74,000	North	
1986	1999	135,000	North	
1999	2000	135,000	North	****
2000	2001	135,000	North	****
2001	2002	135,000	North	****
2002	2003	135,000	North	****
1986	2003	74,000	North	****
1992	2003	135,000	North	****

Notes:
* Using WIS Hindcast Data for Station 130
** + value indicates northbound, - indicates southbound
*** WIS data not available after 1999, the composite longshore transport rates for 1986-2003 was assumed
**** values beyond 1999 are assumed to be equal to rate to 1999

Longshore Transport Rate Uncertainty at Manasquan Inlet

Longshore transport rates for each year were developed for Manasquan Inlet in order to determine the variability (uncertainty) of the data. The uncertainty was assumed to be represented by the standard deviation of the yearly net transport rates, as shown in Table 6b, and as suggested by ERDC “Estimating Uncertainty in Coastal Inlet Sediment Budgets CIRP Technology-Transfer Workshop” by Nick Kraus. As seen in Table 6b, the data set contains great variance, and hence an uncertainty value of +/- 320,000 cy, or 237% of the average net rate.

Table 6b
WIS Station 130 Potential Transport Rates by Year

Year	WIS North Directed cy/yr	WIS South Directed cy/yr	WIS Gross cy/yr	WIS Net cy/yr	Net Direction
1980	811,000	(1,049,000)	1,860,000	(238,000)	North
1981	809,000	(726,000)	1,535,000	83,000	North
1982	835,000	(839,000)	1,674,000	(4,000)	North
1983	981,000	(985,000)	1,966,000	(4,000)	North
1984	1,213,000	(841,000)	2,054,000	372,000	North
1985	755,000	(648,000)	1,403,000	107,000	North
1986	915,000	(683,000)	1,598,000	232,000	North
1987	633,000	(1,144,000)	1,777,000	(511,000)	North
1988	931,000	(453,000)	1,384,000	478,000	North
1989	1,034,000	(808,000)	1,842,000	226,000	North
1990	1,234,000	(474,000)	1,708,000	760,000	North
1991	923,000	(996,000)	1,919,000	(73,000)	North
1992	1,113,000	(1,186,000)	2,299,000	(73,000)	North
1993	1,377,000	(1,263,000)	2,640,000	114,000	North
1994	1,419,000	(1,236,000)	2,655,000	183,000	North
1995	1,536,000	(896,000)	2,432,000	640,000	North
1996	1,989,000	(1,328,000)	3,317,000	661,000	North
1997	1,127,000	(731,000)	1,858,000	396,000	North
1998	1,229,000	(1,390,000)	2,619,000	(161,000)	North
1999	1,265,000	(1,032,000)	2,297,000	233,000	North
Standard Deviation				320,000	

Sediment Budget Assumptions

No offshore losses were assumed across the oceanward boundary. Volumetric accretion was assumed to be retained in the cell, and thus taken out of the amt available to transport into the next adjacent cell. Erosion was assumed to increase the amt of sediment available to be transported to the next cell. Sign convention is positive indicates northbound transport; and negative, southbound. Potential transport rates for computed using WIS hindcast data relevant to Cells 1 through 7, and using Long Branch wave gage relevant to Cell 4 for each period of analysis, as a comparison to resulting sediment budget longshore transport rates.

Sediment Budget Results

Resulting sediment budgets (along with the potential transport rates) are shown below.

- **1986-1992**

This period, and shown in Table 7 represents a period prior to any beachfill placements. The sediment budget starts with 50,000 cy/yr entering into the Cell 1, and shows a transport direction reversal at Cell 3 from north to southward transport. The potential transport predicts net northward transport for all the cells, however the southward transport between Cells 3 and 4, Cells 4 and 5, and Cells 5 and 6 are within the predicted south directed potential transport (see percentage of Potential column on Table 7. The southward transport between Cells 6 and 7 exceeds the potential transport estimate, therefore this budget is questionable in reasonableness. The fact that every cell showed accretion except Cell 1 seems unusual as no fill was placed during this period. A pre-fill sediment budget, however, is of limited usefulness in this study. The authors are more interested in the post-fill behavior of the sediment budget, in order to better predict fill placement performance.

- **1992-1996**

This sediment budget is shown in Table 8. This period includes the first federal operations of fill placement in Cells 5 and 6 (and a minor local fill in Cell 1). With this fill, the accretion estimated by the volumetric change is reasonable. The transport direction is to the north, with approximately stable transport rates of approx 200,000 cy/yr between entering Cells 1 and leaving Cell 4, and then the northward transport increases from Cell 4 to Cell 5 boundary north to 942,000 cy/yr leaving the Sandy Hook cell to the north. Previous sediment budgets have estimated approximately 350,000 cy/yr leaving that cell. The transport rates are in line with the predicted WIS potential transport rates (see Percentage of Potential data in Table 8. The Long Branch gage potential transport is higher, and the sediment budget transport rates are well within this estimate as well. Three significant storm events occurred during this period. It makes sense that more material moves north, in the sediment-rich post-fill condition in conjunction with the storm events. This budget seems reasonable.

- **1996-1998**

This sediment budget is shown in Table 9. This time period reflects 3 fill operations: Park Service fill in Sandy Hook critical zone (Cell 7), initial fill in Long Branch (Cell 4), and in Asbury South (Cell 1). This budget begins with 175,000 cy/yr entering Cell 1 from the south. The transport rates rapidly increase to 946,000 cy/yr due to the fill placed in the cell. The transport rate then stays roughly stable till Cell 4, and then has another jump (increase) due to the fill placement in Cell 4 (to 1,374,000 cy/yr between Cells 4 and 5, both of which exceed the potential transport rate). Cell 5 shows a large accretion (1,600,000 cy/yr) during this period, and this drives the transport direction to change from northward to southward between Cells 6 and 7. And that, coupled with a large accretion in Cell 7 lead to a large southward transport rate of 1,334,000 cy/yr entering Cell 7 from the north, which far exceeds the potential transport. Therefore this budget is questionable in reasonableness.

- **1998-1999**

This sediment budget is shown in Table 10. This budget begins with 59,000 cy/yr moving south (out of) Cell 1. Southbound transport increases in magnitude (exceeding the potential transport by Cell 3) as we look at the cells to the north. Cells 1, 2,and 3 experienced accretion this period, with no added fill placement. Fill was added to Cell 4, but the volumetric change in Cell 4 is almost double the fill rate (2,018,000 cy/yr placed; 3,823,000 cy/yr accreted). New fill was placed in Cell 5 (655,000 cy/yr), however the cell still showed an almost equivalent amount of erosion (578,000 cy/yr). The southward transport rates reach a peak between Cells 4 and 5 (3,243,000 cy/yr), and then slowly decrease (due to the addition of material made available by erosion in Cells 5, 6, and 7) to 1,776,000 cy/yr southward transport coming into Cell 7 from the north. The volumetric change gains shown in cells 1, 2, and 3 can be attributed to the fill placement during the previous period migrating northward. The transport between Cells 2 and 7 greatly exceed the estimated potential southward transport rates, therefore this budget is questionable in reasonableness.

- **1999-2000**

No WIS potential transport rate estimates exist beyond 1999, only Long Branch gage data, when it was functioning. The budget begins with a longshore transport rate of 135,000 cy/yr entering Cell 1 from the south, increasing to a maximum of 1,076,000 cy/yr to the north between Cells 4 and 5, then decreasing to 316,000 cy/yr to the north leaving Cell 7. The volumetric changes seem to belie the fact that significant fill was place in the previous period, although the changes do reflect the placement in Cell 2 (2,657,000 cy/yr) during this period. The sediment budget transport values seem to be within reason. The transport rate between Cells 3 and 4 is approximately 49% of the Long Branch estimated northward potential transport, which is well within reason. It was initially unexpected that the transport rate reaches its maximum between cells 4 and 5 as opposed to north of cell 6; however, this is in line with the fill placement location during the previous period. This budget is assumed to be reasonable.

- **2000-2001**

No potential transport estimates are available for this period. The budget begins with 135,000 cy/yr to the north entering Cell 1 from the south. 208,000 cy/yr of fill was placed in Cell 2, and Cells 1, 2, and 3 are all mildly accretionary (3,000 cy/yr, 110,000 cy/yr, and 11,000 cy/yr, respectively), keeping the northward longshore transport rate roughly constant at 200,000 cy/yr. Cell 4 shows erosion during this period (makes sense following the placement during the pervious period), which shifts the northward longshore transport to a peam of 377,000 cy/yr leaving Cell 4. Cells 5, and 6, show accretion, which decreases the northward longshore transport to approximately 104,000 cy/yr leaving Cell 6. More accretion in Cell 1 results in a change in transport direction leaving 29,000 cy/yr southward from Cell 7 into Cell 6. One storm occurred during this period. No potential data was available for comparison. This budget is somewhat reasonable.

- **2001-2002**

Out of all the periods, this period and the following period are the most questionable. This period predicts almost 2,000,000 cy/yr of sediment movement to the south at Sandy Hook! The predicted longshore transport rate of 1,617,000 cy/yr to the south between Cells 3 and 4 grossly exceed the estimated southward potential rate at the Long Branch Gage. Do not use.

- **2002-2003**

As with the previous period, the transport rates are anomalous here; in fact the most anomalous of all the data periods. Approximately 5,000,000 cy/yr of sediment is estimated to move to the north (approx 5 times the past period potentials)! The opposite directions and large magnitudes of this period and the previous period could indicate a problem with the 2002 data set (shared by both periods). Do not use. Three storms were noted during this period (2002-2003) by the NDBC Bouy 44025 (Long Branch gage was down). Transport is off by orders of magnitude, regardless. Do not use.

- **1986-2003**

Overall, this data period seems on the low side. All cells received fill (except Cell 3), and all cells show accretion approximately equal to the fill rate. Therefore the northward longshore transport increases from 74,000 cy/yr entering Cell 1 from the south, increasing gently to 219,000 cy/yr of northward transport leaving Cell 7. The transport rates are approximately 20% of the potential transport rate predicted by WIS hindcast data. This may be reasonable as the fill is concentrated in the last half of the data period, i.e., the first half reflects a no fill condition. None of the data contradicts the potential values or net directions. This data isn't unreasonable, but may not best reflect the "with-project" sediment budget condition.

- **1992-2003**

For the purposes of developing a sediment budget reflecting the with-project conditions, this period was selected as most representative. This data is similar in magnitude and trend to both Caldwell (1966) and CHL (1989) (see Figure 16; NOTE-data in Figure 16 is in cubic meters/year. In order to convert cm/yr to cy/yr, multiply the cm/yr values by 1.308). Like the previous period, all cells receive fill, except for Cell 3, and all cells show accretion slightly lower than the fill rates. Thereby the fill provides material to the longshore transport system, as expected. The longshore transport rates climb slowly from the 135,000 cy/yr entering Cell 1 from the south, to 627,000 cy/yr northward transport leaving Cell 7. The transport rates increase from ~15% of the potential northbound transport below Cell 1 to 55% leaving Cell 7. And if you look at the comparison between the sediment budget longshore transport rates to the NET potentials, the results are even closer (~45% to 80%)

Results.

The selected sediment budget to represent with-project conditions from Manasquan Inlet to Seabright, NJ is the 1992-2003 budget. A visual representation is shown in Figure 17.

One of the first things to note is that the WIS hindcast waves reflect a more active wave environment for the 1992-2003 period compared to the1986-1992 period. The potential transport predictions are about 50% higher at Sandy Hook, to more than double for Cells 1 and 2. Hence it is not surprising that there is more northward longshore transport predicted for the post-fill period than for the pre-fill period.

WIS hindcast data was used to estimate ratios of northbound transport to southbound transport. These ratios were then utilized to develop rough estimates of northbound and southbound transport between cells. These estimates are a function of the hindcast data collection and analysis process, and are assumed to be reconnaissance level estimates. Further data collection and modeling should be performed to verify this budget values prior to design.

In addition, the fact that so much fill was placed (2,286,000 cy/yr between 1992 and 2003), and that the accreted material is about 78% of the placed material, 22% of the placed material was able to be mobilized into the longshore transport system. The General Design memorandum estimated that approximately 32% of placed fill would be lost to the offshore. This not clearly born out by this sediment budget. However, it is possible that the 1986-1992 period, having the milder wave climate and no significant storms of record, enabled sediment to be transported onshore from offshore, hence leading to the mild accretion shown in this period. And in comparison, the more severe wave climate from 1992-2003, with overall larger waves, and dozens of significant storm events, it is possible that sediment got transported offshore beyond the depth of closure, lost to the littoral system. More study would be needed to evaluate this possibility.

Another observation that can be made is that the post-fill condition covered most of the groins in the project area, and some groins have already been notched to facilitate longshore transport, so again, the higher longshore transport rate occurring with the beachfill in place is expected (fewer shore perpendicular structural impediments).

Final Sediment Budget Uncertainty Rates

Uncertainties arise in sediment budgets due to physical data collection limitations. In this sediment budget, uncertainties for placement volumes, shoreline change volumes were taken into consideration, as well as the uncertainty in the WIS net longshore transport rate entering the study area at Manasquan Inlet (135,000 cy/yr +/- 320,000 cy/yr). The basis for the 18% uncertainty assumption in placement volumes is 15% loss of fines, and 3% overfill ratio. The uncertainty estimate for shoreline change volumes includes uncertainty in berm elevation (standard deviation of 1.3 ft.), depth of closure (standard deviation of 3 ft.), alongshore measurement possible error (assumed 500 ft per 16000 ft), and shoreline position possible error (assumed 4 ft for each shoreline over each 100 ft). The resulting shoreline change volume uncertainty rate is 25%. These uncertainties, when combined with the WIS 237% uncertainty via root mean square method, result in longshore transport rate uncertainties approximate 250%, as displayed on Table 17.

Final Conclusions.

In conclusion, the with-project sediment budget has shown that the beachfill project is performing as expected. The placements have added fill to the long-starved longshore transport system, and have maintained adequate fill between the nourishment cycles. Several cells remain accretionary for a while after each placement, and in fact, the nourishment operations have been able to decrease in frequency due to fill longevity. This sediment budget is on too large a scale to provide any guidelines on erosion hot spots. Due to the erosive nature of the Sandy Hook critical zone, continued coordination with the National Park Service is recommended to facilitate the greatest longevity of the fill in the system. Once the fill leaves the Sandy Hook point, it is lost to the system, unable to be retrieved effectively or efficiently. To backpass the migrated beachfill from northern Sandy Hook would extend the life of the Seabright Borrow Area, and keep the beach quality sand in the system for a much longer period. Monitoring activities are recommended to continue: profiles, shorelines, grain size in order to better predict fill longevity and fill needs. Comparative offshore bathymetry, extending from the shoreline to the depth of closure, would benefit the project greatly, as sand bar formation, and on-offshore transport beyond the depth of closure would be an invaluable tool in project lifetime sediment conservation.

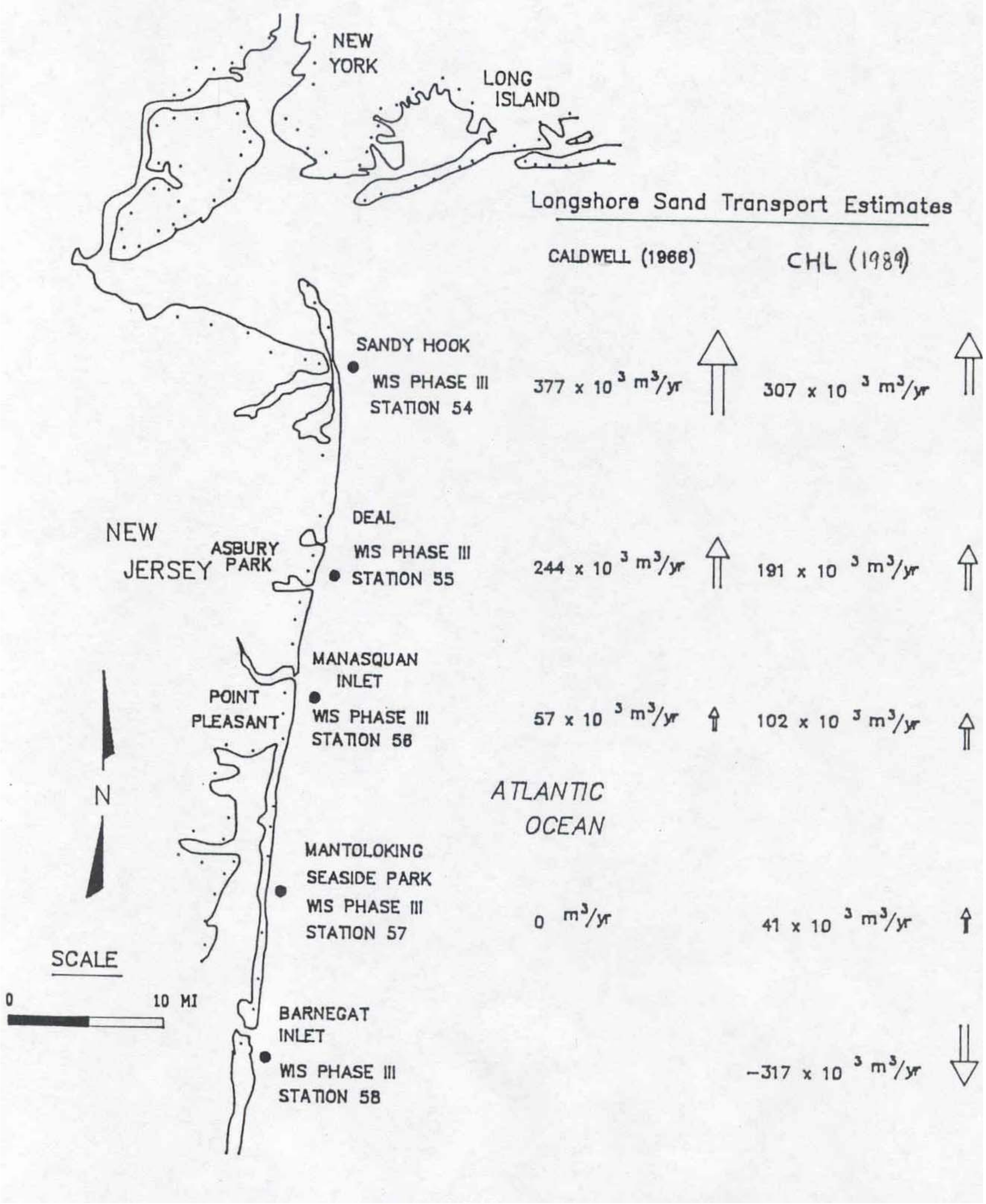

NEW YORK
LONG ISLAND
Longshore Sand Transport Estimates
CALDWELL (1966)
CHL (1989)
SANDY HOOK
WIS PHASE III STATION 54
377 x 10 ^{3} m^3/yr
307 x 10 ^{3} m^3/yr
DEAL
NEW JERSEY
ASBURY PARK
WIS PHASE III STATION 55
244 x 10 ^{3} m^3/yr
191 x 10 ^{3} m^3/yr
MANASQUAN INLET
POINT PLEASANT
WIS PHASE III STATION 56
57 x 10 ^{3} m^3/yr
102 x 10 ^{3} m^3/yr
ATLANTIC OCEAN
N
MANTOLOKING
SEASIDE PARK
WIS PHASE III STATION 57
0 m^3/yr
41 x 10 ^{3} m^3/yr
SCALE
0
10 MI
BARNEGAT INLET
WIS PHASE III STATION 58
–317 x 10 ^{3} m^3/yr

Figure 16

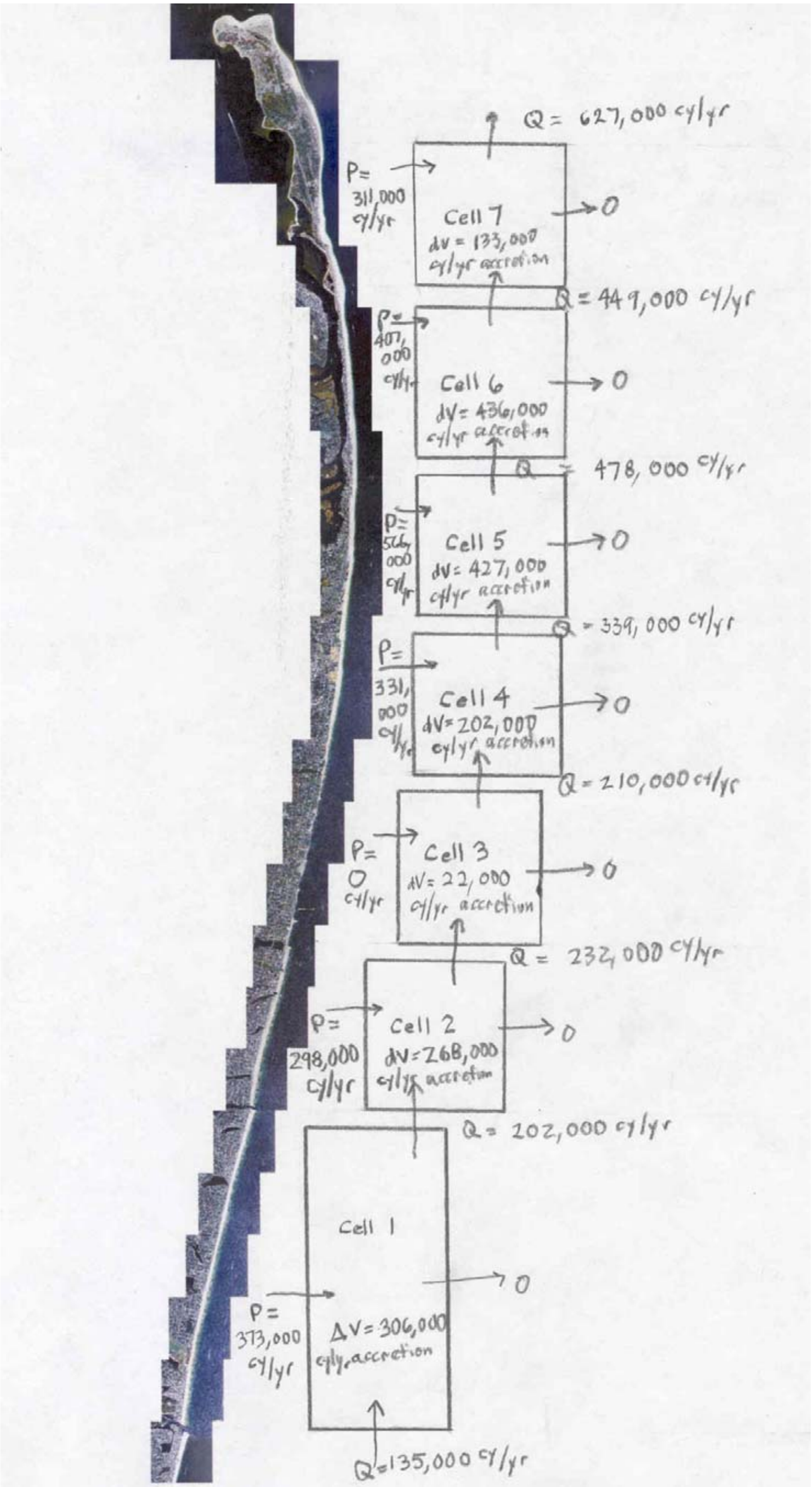

Q = 627,000 cy/yr
P= 311,000 cy/yr
Cell 7
dv = 133,000 cy/yr accretion
→ 0
Q = 449,000 cy/yr
P= 407,000 cy/yr
Cell 6
dV= 436,000 cy/yr accretion
→ 0
Q = 478,000 cy/yr
P= 566,000 cy/yr
Cell 5
dV= 427,000 cy/yr accretion
→ 0
Q = 339,000 cy/yr
P= 331,000 cy/yr
Cell 4
dV= 202,000 cy/yr accretion
→ 0
Q = 210,000 cy/yr
P= 0 cy/yr
Cell 3
dV= 22,000 cy/yr accretion
→ 0
Q = 232,000 cy/yr
P= 298,000 cy/yr
Cell 2
dV= 268,000 cy/yr accretion
→ 0
Q = 202,000 cy/yr
Cell 1
→ 0
P= 373,000 cy/yr
ΔV= 306,000 cy/yr accretion
Q=135,000 cy/yr

Figure 17

Table 7
1986-1992 Sediment Budget

Control Volume ID	WIS North Directed cy/yr	WIS South Directed cy/yr	WIS Gross cy/yr	WIS Net cy/yr	Transport Direction	Gage North Directed cy/yr	Gage South Directed cy/yr	Gage Gross cy/yr	Gage Net cy/yr	Transport Direction	Placement Volume P cy/yr	Volumetric Change dV* cy/yr	Longshore Transport Q ** cy/yr	Transport Direction	Percentage of Potential
	783,000	(145,000)	928,000	638,000	North								n/a		n/a
Cell 7											510,000	n/a			
	783,000	(145,000)	928,000	638,000	North								(360,000)	South	248%
Cell 6											0	116,000			
	711,000	(290,000)	1,001,000	421,000	North								(244,000)	South	84%
Cell 5											0	43,000			
	711,000	(290,000)	1,001,000	421,000	North								(201,000)	South	69%
Cell 4											0	111,000			
	691,000	(407,000)	1,098,000	284,000	North	***	***						(90,000)	South	22%
Cell 3											0	119,000			
	691,000	(407,000)	1,098,000	284,000	North								29,000	North	4%
Cell 2											0	56,000			
	740,000	(556,000)	1,296,000	184,000	North								85,000	North	11%
Cell 1											0	(35,000)			
	716,000	(666,000)	1,382,000	50,000	North								50,000	North	7%
Manasquan Inlet															

Notes: * positive is accretion, negative is erosion

** positive is northbound, negative is southbound

*** insufficient data

Table 8
1992-1996 Sediment Budget

Control Volume ID	WIS North Directed cy/yr	WIS South Directed cy/yr	WIS Gross cy/yr	WIS Net cy/yr	Transport Direction	Gage North Directed cy/yr	Gage South Directed cy/yr	Gage Gross cy/yr	Gage Net cy/yr	Transport Direction	Placement Volume P cy/yr	Volumetric Change dV* cy/yr	Longshore Transport Q ** cy/yr	Transport Direction	Percentage of Potential
	1,249,000	(164,000)	1,413,000	1,085,000	North								942,000	North	75%
Cell 7****											0	(149,000)			
	1,249,000	(164,000)	1,413,000	1,085,000	North								793,000	North	63%
Cell 6											814,000	352,000			
	1,058,000	(353,000)	1,411,000	705,000	North								331,000	North	31%
Cell 5											986,000	871,000			
	1,058,000	(353,000)	1,411,000	705,000	North								216,000	North	20%
Cell 4											0	(1,000)			
	1,106,000	(523,000)	1,629,000	583,000	North	2,354,000	(16,000)	2,370,000	2,338,000	North			215,000	North	19%
Cell 3											0	6,000			
	1,106,000	(523,000)	1,629,000	583,000	North								221,000	North	20%
Cell 2											0	(18,000)			
	1,102,000	(713,000)	1,815,000	389,000	North								203,000	North	18%
Cell 1											15,000	45,000			
	1,093,000	(860,000)	1,953,000	233,000	North								233,000	North	21%
Manasquan Inlet															

Notes: * positive is accretion, negative is erosion

** positive is northbound, negative is southbound

*** insufficient data

**** data from National Park Service augmented with aerial photography

Date		**Storm Event**
12-Nov-95	15-Nov-95	35-hour duration storm, Hmo=4.3 m
07-Jan-96	08-Jan-96	38-hour duration storm, Hmo=3.9 m
19-Mar-96	20-Mar-96	47-hour duration storm, Hmo=3.8 m

Table 9
1996-1998 Sediment Budget

Control Volume ID	WIS North Directed cy/yr	WIS South Directed cy/yr	WIS Gross cy/yr	WIS Net cy/yr	Transport Direction	Gage North Directed cy/yr	Gage South Directed cy/yr	Gage Gross cy/yr	Gage Net cy/yr	Transport Direction	Placement Volume P cy/yr	Volumetric Change dV* cy/yr	Longshore Transport Q ** cy/yr	Transport Direction	Percentage of Potential
	1,185,000	(188,000)	1,373,000	997,000	North								(1,334,000)	South	710%
Cell 7****											191,000	1,121,000			
	1,185,000	(188,000)	1,373,000	997,000	North								(404,000)	South	215%
Cell 6											0	1,629,000			
	1,015,000	(383,000)	1,398,000	632,000	North								1,225,000	North	121%
Cell 5											0	149,000			
	1,015,000	(383,000)	1,398,000	632,000	North								1,374,000	North	135%
Cell 4											1,233,000	703,000			
	1,006,000	(527,000)	1,533,000	479,000	North	2,012,000	(14,000)	2,026,000	1,998,000	North			844,000	North	84%
Cell 3											0	6,000			
	1,006,000	(527,000)	1,533,000	479,000	North								850,000	North	84%
Cell 2											0	96,000			
	1,068,000	(726,000)	1,794,000	342,000	North								946,000	North	89%
Cell 1											2,733,000	1,962,000			
	1,059,000	(884,000)	1,943,000	175,000	North								175,000	North	17%
Manasquan Inlet															

Notes: * positive is accretion, negative is erosion
** positive is northbound, negative is southbound
*** insufficient data
**** data from National Park Service augmented with aerial photography

Date		**Storm Event**	
18-Oct-96	20-Oct-96	85-hour duration storm, Hmo=3.7 m	south
17-Nov-96	20-Feb-97	gage out	
Dec-96		2 storms, no data	
10-Jan-97		1 storm, no data	
21-Aug-97		35-hour duration storm, Hmo=3.1 m	south
07-Nov-97	14-Nov-97	2 storms, Hmo=3.5 m	south
23-Jan-98		1 storms, Hmo=3.6 m	south
28-Jan-98		1 storms, Hmo=3.1 m	south
05-Feb-98	24-Feb-98	3 storms, Hmo=3.9 m	south
21-Mar-98	22-Mar-98	60-hour duration storm, Hm0=3.8 m	

Table 10
1998-1999 Sediment Budget

Control Volume ID	WIS North Directed cy/yr	WIS South Directed cy/yr	WIS Gross cy/yr	WIS Net cy/yr	Transport Direction	Gage North Directed cy/yr	Gage South Directed cy/yr	Gage Gross cy/yr	Gage Net cy/yr	Transport Direction	Placement Volume P cy/yr	Volumetric Change dV* cy/yr	Longshore Transport Q ** cy/yr	Transport Direction	Percentage of Potential
	1,035,000	(232,000)	1,267,000	803,000	North								(1,776,000)	South	766%
Cell 7****											0	(142,000)			
	1,035,000	(232,000)	1,267,000	803,000	North								(1,918,000)	South	827%
Cell 6											0	(92,000)			
	877,000	(457,000)	1,334,000	420,000	North								(2,010,000)	South	440%
Cell 5											655,000	(578,000)			
	877,000	(457,000)	1,334,000	420,000	North								(3,243,000)	South	710%
Cell 4											2,018,000	3,823,000			
	876,000	(640,000)	1,516,000	236,000	North	2,690,000	(27,000)	2,717,000	2,663,000	North			(1,438,000)	South	225%
Cell 3											0	266,000			
	876,000	(640,000)	1,516,000	236,000	North								(1,172,000)	South	183%
Cell 2											0	316,000			
	948,000	(908,000)	1,856,000	40,000	North								(856,000)	South	94%
Cell 1											0	797,000			
	991,000	(1,050,000)	2,041,000	(59,000)	South								(59,000)	South	6%
Manasquan Inlet															

Notes: * positive is accretion, negative is erosion

** positive is northbound, negative is southbound

*** insufficient data

**** data from National Park Service augmented with aerial photography

Date		**Event**
Apr-98	Mar-99	no storms recorded

Table 11

1999-2000 Sediment Budget

Control Volume ID	WIS North Directed cy/yr	WIS South Directed cy/yr	WIS Gross cy/yr	WIS Net cy/yr	Transport Direction	Gage North Directed cy/yr	Gage South Directed cy/yr	Gage Gross cy/yr	Gage Net cy/yr	Transport Direction	Placement Volume P cy/yr	Volumetric Change dV* cy/yr	Longshore Transport Q ** cy/yr	Transport Direction	Percentage of Potential
													316,000	North	
Cell 7****											0	209,000			
	***	***											525,000	North	
Cell 6											0	62,000			
	***	***											587,000	North	
Cell 5											0	489,000			
	***	***											1,076,000	North	
Cell 4											0	(411,000)			
	***	***				1,359,000	(26,000)	1,385,000	1,333,000	North			665,000	North	49%
Cell 3											0	(85,000)			
	***	***											580,000	North	
Cell 2											2,657,000	2,362,000			
	***	***											285,000	North	
Cell 1											0	(150,000)			
	***	***											135,000	North	
Manasquan Inlet															

Notes: * positive is accretion, negative is erosion

** positive is northbound, negative is southbound

*** insufficient data

**** data comes from profile changes above -24 ft. NGVD contour

Date	**Event**
25-Jan-00	48-hour duration storm, Hmo=3.3m

Table 12
2000-2001 Sediment Budget

Control Volume ID	WIS North Directed cy/yr	WIS South Directed cy/yr	WIS Gross cy/yr	WIS Net cy/yr	Transport Direction	Gage North Directed cy/yr	Gage South Directed cy/yr	Gage Gross cy/yr	Gage Net cy/yr	Transport Direction	Placement Volume P cy/yr	Volumetric Change dV* cy/yr	Longshore Transport Q ** cy/yr	Transport Direction	Percentage of Potential
													(29,000)	South	
Cell 7****											0	133,000			
	***	***											104,000	North	
Cell 6											0	178,000			
	***	***											282,000	North	
Cell 5											0	95,000			
	***	***											377,000	North	
Cell 4											0	(158,000)			
	***	***				***	***						219,000	North	
Cell 3											0	11,000			
	***	***											230,000	North	
Cell 2											208,000	110,000			
	***	***											132,000	North	
Cell 1											0	3,000			
	***	***											135,000	North	
Manasquan Inlet															

Notes: * positive is accretion, negative is erosion

** positive is northbound, negative is southbound

*** insufficient data

**** assume Feb-92 to May-00 rate on Table 5b is valid for this time period.

Date	**Event**
26-Sep-00	Tropical Storm Helene, 54-hour duration, Hmo=3.9 (from NDBC Bouy 44025 record)

Table 13

2001-2002 Sediment Budget

Control Volume ID	WIS North Directed cy/yr	WIS South Directed cy/yr	WIS Gross cy/yr	WIS Net cy/yr	Transport Direction	Gage North Directed cy/yr	Gage South Directed cy/yr	Gage Gross cy/yr	Gage Net cy/yr	Transport Direction	Placement Volume P cy/yr	Volumetric Change dV* cy/yr	Longshore Transport Q ** cy/yr	Transport Direction	Percentage of Potential
	***	***											(1,728,000)	South	
Cell 7**											0	133,000			
	***	***											(1,595,000)	South	
Cell 6											0	112,000			
	***	***											(1,483,000)	South	
Cell 5											0	20,000			
	***	***											(1,463,000)	South	
Cell 4											0	(154,000)			
	***	***				850,000	(9,000)	859,000	841,000	North			(1,617,000)	South	17967%
Cell 3											0	390,000			
	***	***											(1,227,000)	South	
Cell 2											0	766,000			
	***	***											(461,000)	South	
Cell 1											0	596,000			
	***	***											135,000	North	
Manasquan Inlet															

Notes: * positive is accretion, negative is erosion

** positive is northbound, negative is southbound

*** insufficient data

**** assume Feb-92 to May-00 rate on Table 5b is valid for this time period.

Date		**Event**
Jul-01	Apr-02	no storms recorded

Table 14
2002-2003 Sediment Budget

Control Volume ID	WIS North Directed cy/yr	WIS South Directed cy/yr	WIS Gross cy/yr	WIS Net cy/yr	Transport Direction	Gage North Directed cy/yr	Gage South Directed cy/yr	Gage Gross cy/yr	Gage Net cy/yr	Transport Direction	Placement Volume P cy/yr	Volumetric Change dV* cy/yr	Longshore Transport Q ** cy/yr	Transport Direction	Percentage of Potential
	***	***											4,793,000	North	
Cell 7****											300,000	133,000			
	***	***											4,626,000	North	
Cell 6											750,000	508,000			
	***	***											4,384,000	North	
Cell 5											1,125,000	326,000			
	***	***											3,585,000	North	
Cell 4											0	(1,513,000)			
	***	***				***	***						2,072,000	North	
Cell 3											0	(275,000)			
	***	***											1,797,000	North	
Cell 2											0	(874,000)			
	***	***											923,000	North	
Cell 1											0	(788,000)			
	***	***											135,000	North	
Manasquan Inlet															

Notes: * positive is accretion, negative is erosion

** positive is northbound, negative is southbound

*** insufficient data

**** assume Feb-92 to May-00 rate on Table 5b is valid for this time period.

Date	**Event**
25-Dec-02	48-hour duration storm, Hmo=5.0 m*
03-Jan-03	108-hour duration storm, Hmo=4.7m*
18-Apr-03	1-week duration storm, Hmo=3.6m*

Table 15
1986-2003 Sediment Budget

Control Volume ID	WIS North Directed cy/yr	WIS South Directed cy/yr	WIS Gross cy/yr	WIS Net cy/yr	Transport Direction	Gage North Directed cy/yr	Gage South Directed cy/yr	Gage Gross cy/yr	Gage Net cy/yr	Transport Direction	Placement Volume P cy/yr	Volumetric Change dV* cy/yr	Longshore Transport Q ** cy/yr	Transport Direction	Percentage of Potential
	948,000	(157,000)	1,105,000	791,000	North								219,000	North	23%
Cell 7****											206,000	133,000			
	948,000	(157,000)	1,105,000	791,000	North								146,000	North	15%
Cell 6											270,000	328,000			
	738,000	(320,000)	1,058,000	418,000	North								204,000	North	28%
Cell 5											376,000	298,000			
	738,000	(320,000)	1,058,000	418,000	North								126,000	North	17%
Cell 4											220,000	172,000			
	895,000	(501,000)	1,396,000	394,000	North	1,506,000	(170,000)	1,676,000	1,336,000	North			78,000	North	9%
Cell 3											0	54,000			
	895,000	(501,000)	1,396,000	394,000	North								132,000	North	15%
Cell 2											198,000	197,000			
	850,000	(638,000)	1,488,000	212,000	North								131,000	North	15%
Cell 1											248,000	191,000			
	840,000	(766,000)	1,606,000	74,000	North								74,000	North	9%
Manasquan Inlet															

Notes: * positive is accretion, negative is erosion

** positive is northbound, negative is southbound

*** insufficient data

**** assume Feb-92 to May-00 rate on Table 5b is valid for this time period.

Date		**Event**
12-Nov-95	15-Nov-95	35-hour duration storm, Hmo=4.3 m
07-Jan-96	08-Jan-96	38-hour duration storm, Hmo=3.9 m
19-Mar-96	20-Mar-96	47-hour duration storm, Hmo=3.8 m
18-Oct-96	20-Oct-96	85-hour duration storm, Hmo=3.7 m
17-Nov-96	20-Feb-97	gage out
Dec-96		2 storms, no data
10-Jan-97		1 storm, no data
21-Aug-97		35-hour duration storm, Hmo=3.1 m
07-Nov-97	14-Nov-97	2 storms, Hmo=3.5 m
23-Jan-98		1 storms, Hmo=3.6 m
28-Jan-98		1 storms, Hmo=3.1 m
05-Feb-98	24-Feb-98	3 storms, Hmo=3.9 m
21-Mar-98	22-Mar-98	60-hour duration storm, Hm0=3.8 m
25-Jan-00		48-hour duration storm, Hmo=3.3m
26-Sep-00		Tropical Storm Helene, 54-hour duration, Hmo=3.9 m*
Jul-01	01-Apr-02	no storms recorded
25-Dec-02		48-hour duration storm, Hmo=5.0 m*
03-Jan-03		108-hour duration storm, Hmo=4.7m*
18-Apr-03		1-week duration storm, Hmo=3.6m*

Table 16
1992-2003 Sediment Budget

Control Volume ID	WIS North Directed Transport cy/yr	WIS South Directed Transport cy/yr	WIS Gross Transport cy/yr	WIS Net Transport cy/yr	WIS Transport Direction	Gage North Directed Transport cy/yr	Gage South Directed Transport cy/yr	Gage Gross Transport cy/yr	Gage Net Transport cy/yr	Transport Direction	Placement Volume P cy/yr	Volumetric Change dV* cy/yr	NET Longshore Transport Q ** cy/yr	Transport Direction	WIS Ratio QN/QS	South Directed Transport cy/yr	North Directed Transport cy/yr
	1,135,000	(167,000)	1,302,000	968,000	North								627,000	North	(6.8)	(108,000)	734,000
Cell 7****											311,000	133,000					
	1,135,000	(167,000)	1,302,000	968,000	North								449,000	North	(6.8)	(77,000)	523,000
Cell 6											407,000	436,000					
	952,000	(354,000)	1,306,000	598,000	North								478,000	North	(2.7)	(283,000)	761,000
Cell 5											566,000	427,000					
	952,000	(354,000)	1,306,000	598,000	North								339,000	North	(2.7)	(201,000)	541,000
Cell 4											331,000	202,000					
	999,000	(519,000)	1,518,000	480,000	North	1,506,000	(170,000)	1,676,000	1,336,000	North			210,000	North	(1.9)	(227,000)	437,000
Cell 3											0	22,000					
	999,000	(519,000)	1,518,000	480,000	North								232,000	North	(1.9)	(251,000)	483,000
Cell 2											298,000	268,000					
	1,128,000	(718,000)	1,846,000	410,000	North								202,000	North	(1.6)	(354,000)	556,000
Cell 1											373,000	306,000					
	994,000	(859,000)	1,853,000	135,000	North								135,000	North	(1.2)	(859,000)	994,000
Manasquan Inlet																	

Notes: * positive is accretion, negative is erosion

** positive is northbound, negative is southbound

*** insufficient data

**** assume Feb-92 to May-00 rate on Table 5b is valid for this time period.

Date		**Event**
12-Nov-95	15-Nov-95	35-hour duration storm, Hmo=4.3 m
07-Jan-96	08-Jan-96	38-hour duration storm, Hmo=3.9 m
19-Mar-96	20-Mar-96	47-hour duration storm, Hmo=3.8 m
18-Oct-96	20-Oct-96	85-hour duration storm, Hmo=3.7 m
17-Nov-96	20-Feb-97	gage out
Dec-96		2 storms, no data
10-Jan-97		1 storm, no data
21-Aug-97		35-hour duration storm, Hmo=3.1 m
07-Nov-97	14-Nov-97	2 storms, Hmo=3.5 m
23-Jan-98		1 storms, Hmo=3.6 m
28-Jan-98		1 storms, Hmo=3.1 m
05-Feb-98	24-Feb-98	3 storms, Hmo=3.9 m
21-Mar-98	22-Mar-98	60-hour duration storm, Hm0=3.8 m
25-Jan-00		48-hour duration storm, Hmo=3.3m
26-Sep-00		Tropical Storm Helene, 54-hour duration, Hmo=3.9 m*
Jul-01	01-Apr-02	no storms recorded
25-Dec-02		48-hour duration storm, Hmo=5.0 m*
03-Jan-03		108-hour duration storm, Hmo=4.7m*
18-Apr-03		1-week duration storm, Hmo=3.6m*

Table 17
1992-2003 Sediment Budget with Uncertainties

Control Volume ID	Placement Volume P cy/yr	Placement Volume uncertainty rate	Placement Volume uncertainty cy/yr	Volumetric Change dV* cy/yr	Volumetric Change uncertainty rate	Volumetric Change uncertainty cy/yr	NET Longshore Transport Q ** cy/yr		Longshore Transport Uncertainty Q ** cy/yr	Longshore Transport Uncertainty Rate cy/yr	Transport Direction	WIS Ratio QN/QS	South Directed Transport cy/yr	North Directed Transport cy/yr
							627,000	+/-	1,572,000	251%	North	(6.8)	(108,000)	734,000
Cell 7****	311,000	18%	56,000	133,000	25%	33,000								
							449,000	+/-	1,117,000	249%	North	(6.8)	(77,000)	523,000
Cell 6	407,000	18%	73,000	436,000	25%	109,000								
							478,000	+/-	1,180,000	247%	North	(2.7)	(283,000)	761,000
Cell 5	566,000	18%	102,000	427,000	25%	107,000								
							339,000	+/-	830,000	245%	North	(2.7)	(201,000)	541,000
Cell 4	331,000	18%	60,000	202,000	25%	51,000								
							210,000	+/-	510,000	243%	North	(1.9)	(227,000)	437,000
Cell 3	0	18%	0	22,000	25%	6,000								
							232,000	+/-	559,000	241%	North	(1.9)	(251,000)	483,000
Cell 2	298,000	18%	54,000	268,000	25%	67,000								
							202,000	+/-	483,000	239%	North	(1.6)	(354,000)	556,000
Cell 1	373,000	18%	67,000	306,000	25%	77,000								
							135,000	+/-	320,000	237%	North	(1.2)	(859,000)	994,000
Manasquan Inlet														

Notes: * positive is accretion, negative is erosion

** positive is northbound, negative is southbound

*** insufficient data

**** assume Feb-92 to May-00 rate on Table 5b is valid for this time period.

References

Caldwell, J.M. 1966. “Coastal Processes and Beach Erosion,” Journal of the Society of Civil Engineers, Vol 53, No. 2, pp 142-157. (also reprinted with an abstract and errata as Reprint Report I-67, U.S. Army Coastal Engineering Research Center, Corps of Engineers, 1967.)

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