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# **Wave Climate and Littoral Sediment Transport Study for Virginia Beach, VA – Rudee Inlet to Cape Henry**

Hydraulic Model Study

Michael J. Briggs and Edward F. Thompson

September 2008

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**Abstract:** The Norfolk District is preparing an Environmental Assessment for the use of sand sources off the coast of Cape Henry for future maintenance of the Virginia Beach, VA, shoreline. The primary purpose is to maintain a buffer for hurricane protection for structures landward of the existing beach. The Cape Henry Borrow Area is being considered as a sand source. The plan borrow scenario involves removing approximately 34.2 M cu yd of material from the borrow area over a period of 50 years. The study provided wave climate and potential longshore transport information and analysis for two bathymetric cases: existing bathymetry and planned excavation from the Cape Henry Borrow Area. These two cases bracket the range of expected conditions over the next 50 years and enable assessment of potential project impacts on littoral transport patterns along adjacent beaches during this time frame.

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## **Preface**

This study was authorized by the U.S. Army Engineer District, Norfolk, and was conducted by personnel of the Harbors, Entrances, and Structures Branch, Coastal and Hydraulics Laboratory (CHL), of the U.S. Army Engineer Research and Development Center (ERDC). The study was conducted during the period June 2003 through October 2003. Deborah R. Painter, U.S. Army Engineer District, Norfolk, oversaw progress of the study.

Dr. Michael J. Briggs, Harbors and Entrances Group, Harbors, Entrances, and Structures Branch, CHL, was point of contact for the study. This report was prepared by Dr. Briggs and Dr. Edward F. Thompson, Harbors and Entrances Group, CHL. Leonette J. Thomas, also of Harbors and Entrances Group, CHL, assisted with the preparation of the report. Direct supervision was provided by Dennis G. Markle, currently with the Information Technology Laboratory, ERDC. General supervision was provided by Thomas W. Richardson, Director, CHL, and Dr. James R. Houston, Director, ERDC.

COL Gary E. Johnston was Commander and Executive Director of ERDC. Dr. James R. Houston was Director.

## Unit Conversion Factors

Multiply	By	To Obtain
cubic feet	0.02831685	cubic meters
cubic yards	0.7645549	cubic meters
degree	0.01745329	radians
feet	0.3048	meters
inches	2.54	centimeters
gallons	3.785	liters
miles (nautical)	1,852	meters
square feet	0.09290304	square meters

# 1 Introduction

## Background

The U.S. Army Corps of Engineers, Norfolk District (CENAO), is preparing an Environmental Assessment for the use of sand sources off the coast of Cape Henry for future maintenance of the Virginia Beach, VA, shoreline. The primary purpose of the project is to maintain a buffer for hurricane protection for structures landward of the existing beach.

The study area along the Virginia coast extends along Cape Henry from Rudee Inlet in the south to 89th Street in the north (Figure 1). The beaches experience active movement of littoral sediment in both northward and southward directions, depending on incident wave conditions. The net impact of littoral transport can emerge as sediment accretion in some coastal areas and erosion in other areas.

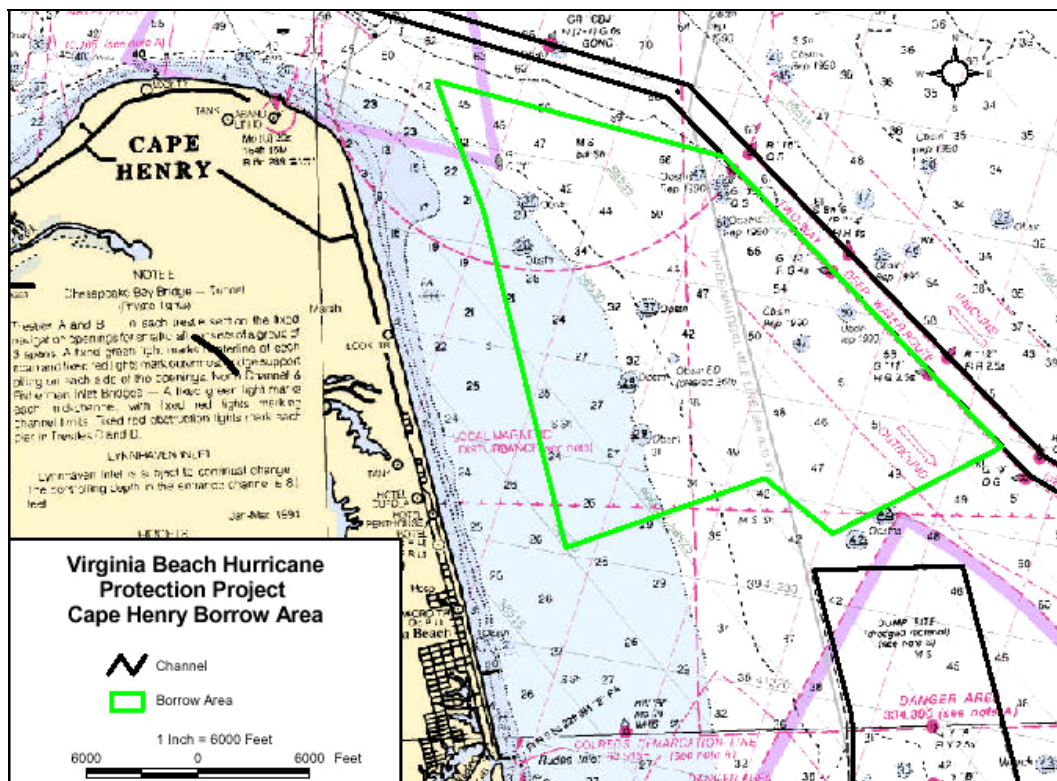


Figure 1. Study area location map (Cape Henry borrow area shown in green).

The Cape Henry borrow area is being considered as a sand source. It is a roughly triangular-shaped area, located adjacent to Virginia Beach, VA, and the Atlantic Ocean Navigation Channel. The plan borrow scenario involves removing approximately 34.2 M cu yd (million cubic yards) of material from the borrow area over a period of 50 years. Plan borrow activities will deepen the existing bottom in the seaward portion of the Cape Henry borrow area by 14 ft (Figure 2). Because significant changes to the Cape Henry borrow area will alter local wave conditions and may affect littoral transport patterns along nearby beaches, analysis of wave transformation and estimates of potential longshore transport were developed for existing and with-project scenarios.

Use of offshore sand sources will modify the bathymetry affecting waves as they approach Virginia Beach. Depending on characteristics of the borrow areas and proximity to shore, the effect on wave climate may extend to the beach and alter littoral transport along the beach. The purpose of the proposed work is to assess the potential impacts of offshore sand removal on nearby beaches.

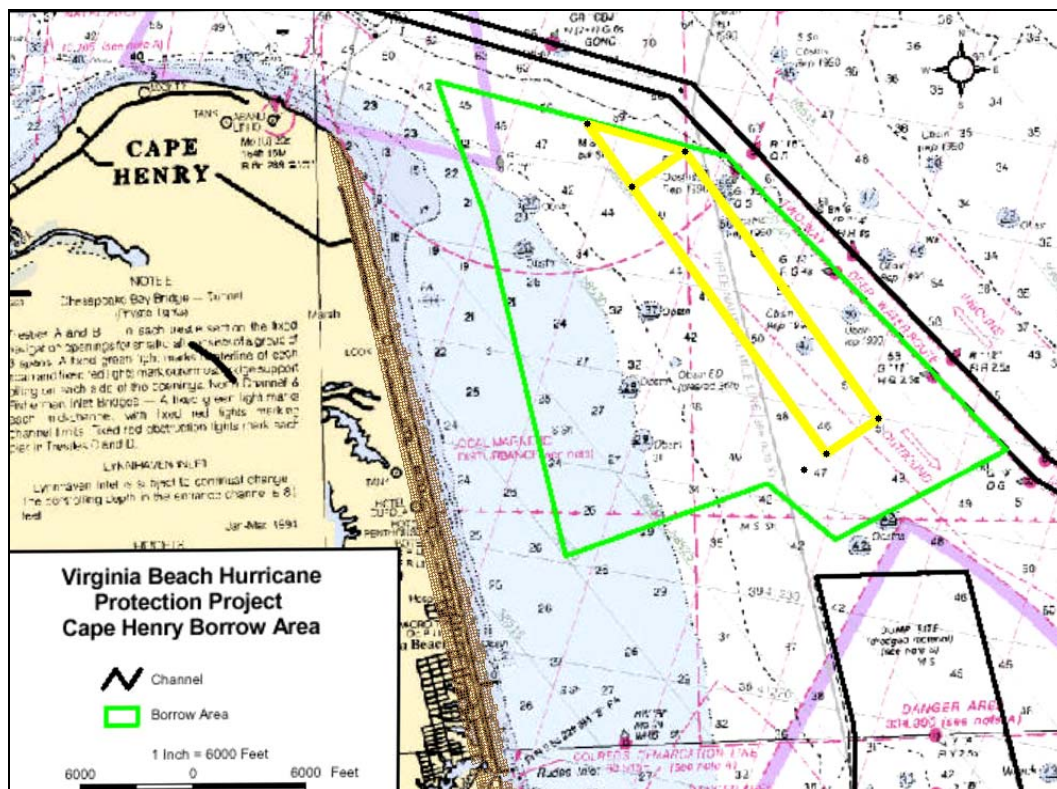


Figure 2. Proposed portion of Cape Henry borrow area used in current study (shown in yellow).

## Need and objective

The use of the Cape Henry borrow area as a sand source may affect littoral transport patterns along nearby beaches landward of this area. CENAO needs information about the magnitude and extent of these impacts along Virginia Beach.

In response to this need, the study objective is to provide wave climate and potential longshore transport information and analysis for two bathymetric cases: existing bathymetry and with planned excavation from the Cape Henry borrow area. These two cases will bracket the range of expected conditions over the next 50 years and enable assessment of potential project impacts on littoral transport patterns along adjacent beaches.

## Study approach

The study described in this report was performed by the U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory (CHL). The approach consisted of the following components:

- Determine appropriate offshore wave climate for the study area.
- Obtain digital bathymetry.
- Use a numerical model to transform offshore wave conditions to coastal areas for two bathymetric configurations.
- Estimate littoral transport potential along the coast, including differences resulting from the two configurations.

Offshore wind-wave and swell climate was represented by Wave Information Studies (WIS) hindcast information covering the 10-year time period 1990–99. The WIS information compared very favorably with National Data Buoy Center (NDBC) data from NDBC Station 44014. The WIS information offered some advantages over NDBC Station 44014 for this study as discussed in Chapter 2, Offshore Wave Climate.

Digital bathymetry was obtained from the National Oceanic and Atmospheric Administration (NOAA) for the study area. Two bathymetric configurations were modeled:

1. *Existing Bathymetry (Figure 3)*. Existing offshore bathymetry within the study area.
2. *Plan 1: Existing Bathymetry with Borrow Pit (Figure 4)*. Modified offshore bathymetry to include proposed pit in Cape Henry borrow area.

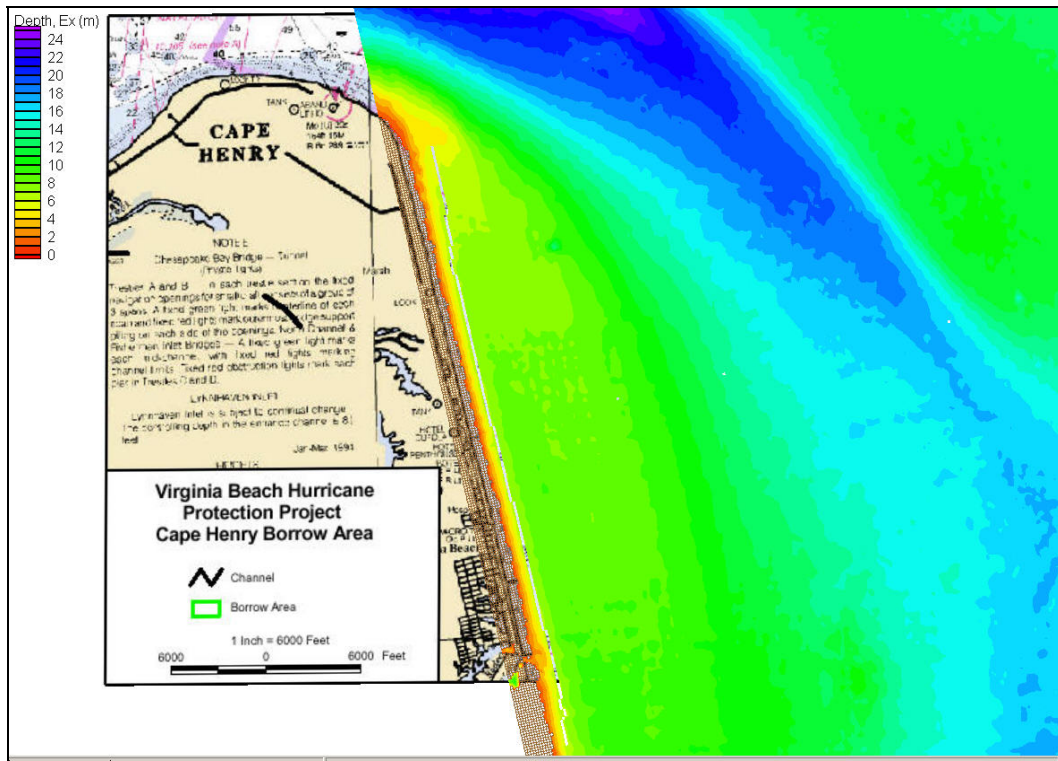


Figure 3. Bathymetry for existing conditions.

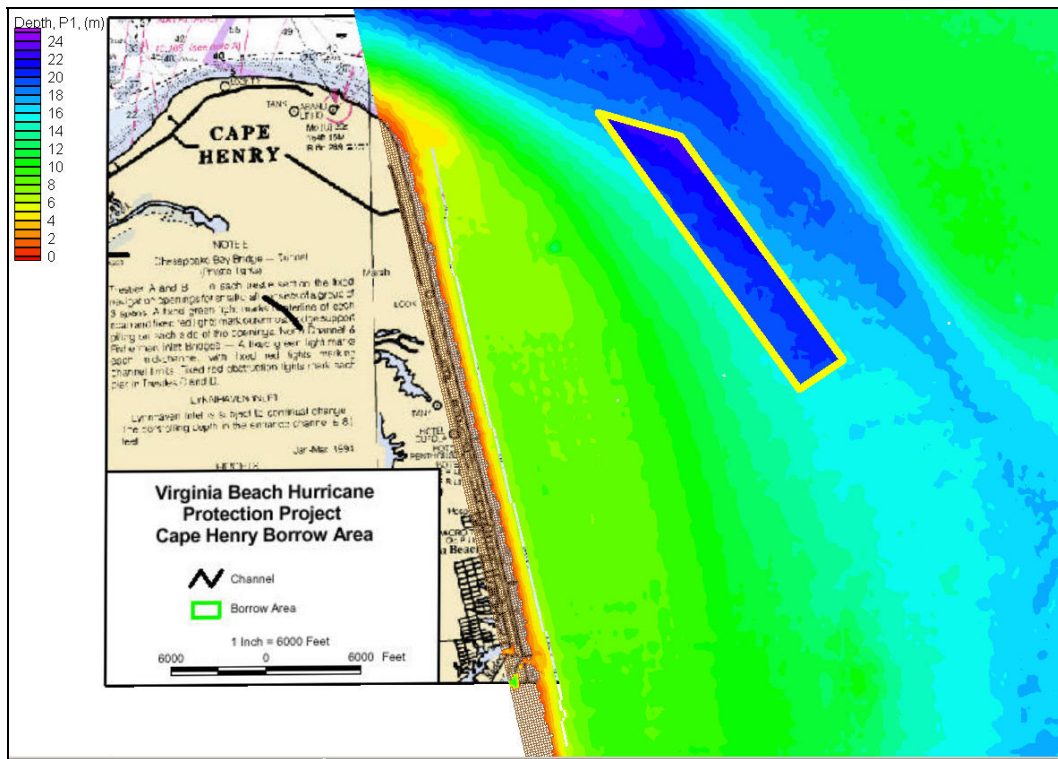


Figure 4. Plan 1 modified existing bathymetry with borrow pit.

Wave transformation from deep to shallow water depths was performed with the finite difference STWAVE (STeady-State Spectral WAVE) model. It includes the coastal processes of refraction, shoaling, and depth-limited wave breaking. The STWAVE model is contained in the SMS (Surface-Water Modeling System 2000): a comprehensive graphical user interface (GUI) for model conceptualization, mesh generation, statistical interpretation, and visual examination of surface water model simulation results.

The model domain extended north into the mouth of Chesapeake Bay and south to near False Cape (Virginia and North Carolina border), beyond expected plan impacts (Figure 5). The computer program VaBeach\_QCalc provided the tool for calculating potential longshore transport rates. Development of numerical model grids, model output stations, longshore sediment transport calculation procedures, and other aspects of the modeling approach are described in Chapter 3.

Study results are presented in Chapters 4 and 5. Nearshore wave transformation results are summarized in Chapter 4. Littoral transport results needed for assessing borrow-area impact on erosion and accretion of adjacent beaches are presented in Chapter 5. Conclusions are given in Chapter 6. This chapter is followed by references cited in the report.

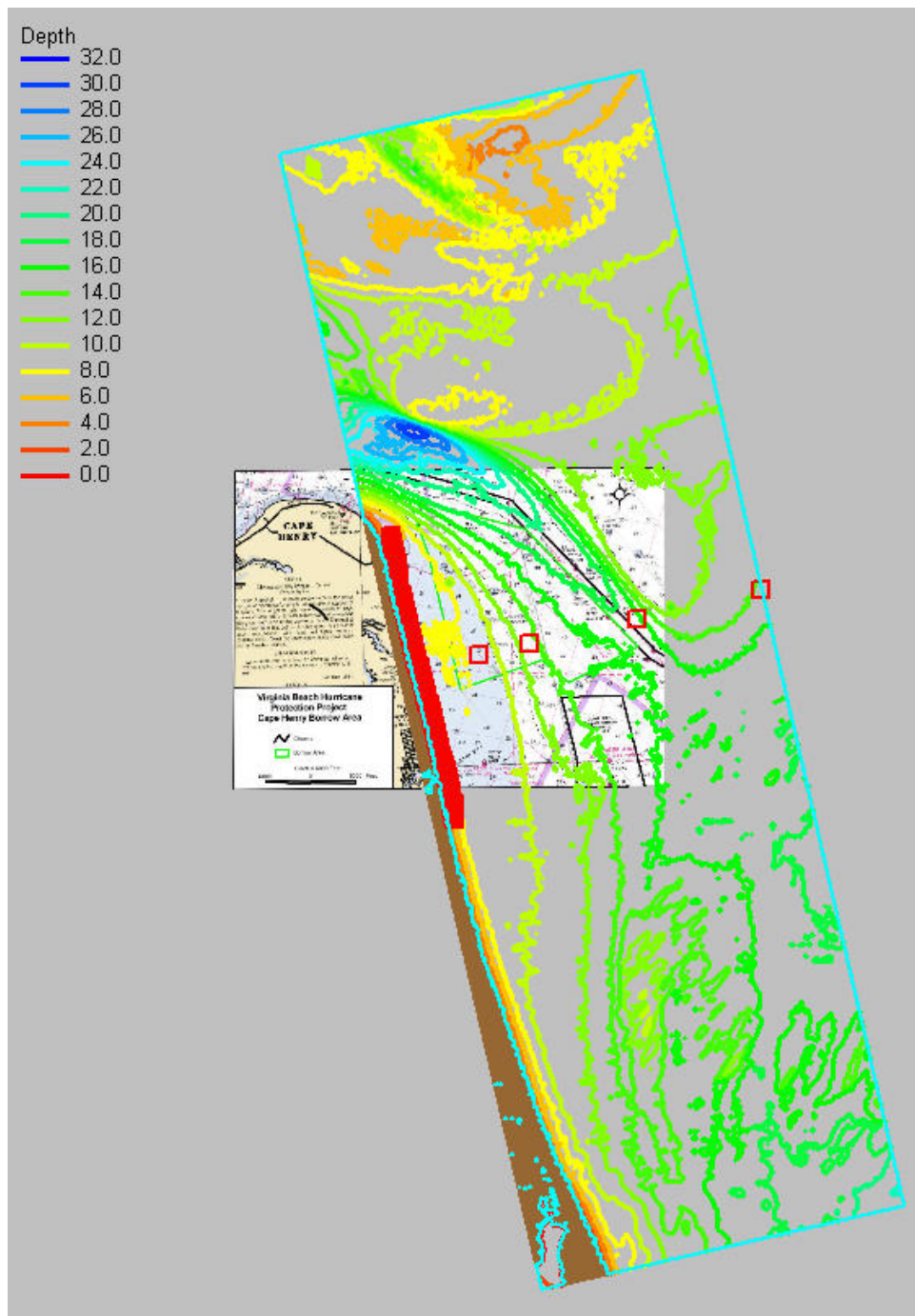


Figure 5. Model extent and existing depth contours (meters) in study area; model output stations shown as red squares.



## 2 Offshore Wave Climate

Determination of the incident wave climate is a critical first step in near-shore wave transformation and littoral transport studies. Ideally, a long-term, high-quality hindcast is available with at least a few years of concurrent directional wave measurements in the same area to validate the hindcast. This study used a relatively recent 10-year hindcast, as discussed in the following paragraphs.

### WIS hindcasts

The Wave Information Studies (WIS) have developed wave information along U.S. coasts by computer simulation of past wind and wave conditions. This type of simulation is termed a hindcast. The present hindcast information base consists of two 20-yr periods and one 10-year period. WIS produced the first period, covering years 1956–75, in the early 1980s (Corson et al. 1982). The second period, covering years 1976–95, was produced in the mid-1990s (Brooks and Brandon 1995). The last period of 10 years from 1990–99 is the most recent and reliable since it was produced using an improved wave hindcast model and results were evaluated against an extensive array of wave measurements that were not available during the two previous time periods. The WIS hindcasts and comparisons with gauge data are easily accessible by Internet for CENAO review at <http://www.frf.usace.army.mil/wis/>.

The 1990–99 WIS parameters are available at 1-hr intervals over the 10-year period. At each 1-hr interval, a number of wave parameters are given. Parameters typically used to represent waves are significant wave height,  $H_{m0}$ , peak spectral wave period,  $T_p$ , and mean direction at the peak frequency,  $\bar{\theta}$ .

Two WIS stations, 197 and 199, are available for analysis within the study area (Figure 6). Station 197 is located 11.5 nm offshore at latitude 36.92 N and longitude 75.75 W in a water depth of 17 m (56 ft). WIS Station 199 is located at latitude 36.83 N and longitude 75.75 W in a depth of 19 m (62 ft). It is a little further south and in deeper water than Station 197. After some comparisons, Station 197 was selected since it is directly offshore from the beaches and thought to be more representative of the study area.

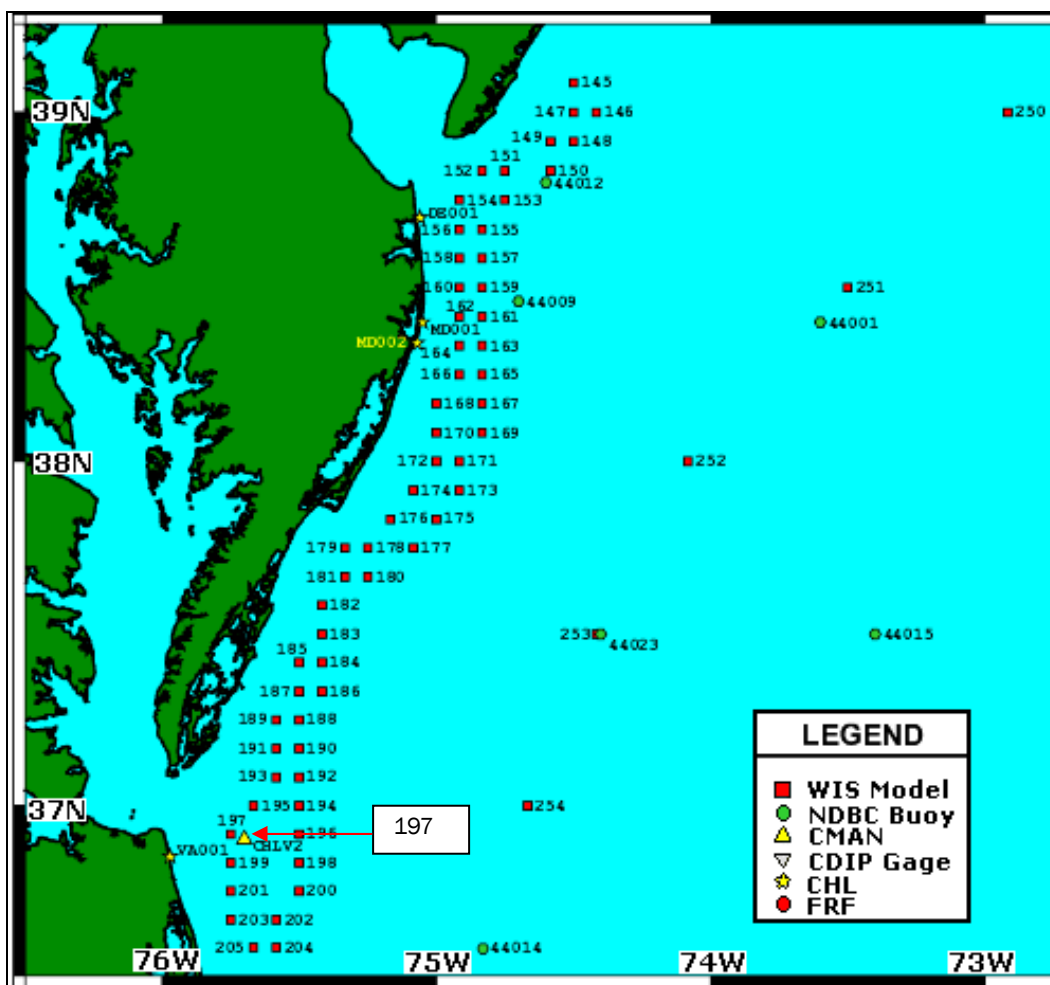


Figure 6. Locations of WIS Stations, NDBC Buoys and CMAN gages in study area. Gage 197 is marked with an arrow and gage 199 is to the south.

The WIS wave information was compared to data from three gage sites in the general location of the study area (Figure 6). The three sites were (1) National Weather Service National Data Buoy Center (NDBC) Buoy 44014 (includes wave direction data), (2) Coastal-Marine Automated Network (CMAN) station at Chesapeake Light, CHLV2 (does not include wave direction), and (3) nearshore CHL gage, VAO01, near Virginia Beach. The NDBC Buoy 44014 is significantly further offshore than the other wave gages and the WIS stations. The Virginia Beach gage was a directional nearshore pressure gage array in 8-m water depth operated by CHL. Additional information and data are available at [http://sandbar.wes.army.mil/public\\_html/pmab2web/htdocs/va001.html](http://sandbar.wes.army.mil/public_html/pmab2web/htdocs/va001.html).

Time history comparisons between the two offshore gage locations and the nearest WIS grid points are available via the WIS Web site. These

comparisons were reviewed over the full ten-year time period. Several individual storms (i.e., October 1991) were examined in close detail and showed good agreement. Overall, the WIS information appears to give a very good representation of local offshore wave climate over the 10-year time period. Based on these results, WIS Station 197 was selected to provide wave climate information of this study since: (a) Station 197 is significantly closer to the study area than NDBC Buoy 44014 and can be used directly as incident waves for STWAVE modeling; (b) hourly wave information, including wave direction, is available over the full 10-year period with no gaps; and (c) WIS hindcasts compare well with available gauge data. One advantage of (a) is that most WIS wave cases are propagating toward shore, while NDBC Buoy 44014, the other possible source of offshore wave direction information, includes a number of cases of waves traveling offshore. If NDBC Buoy 44014 data were used, these cases would be considered as “calms” relative to the Virginia Beach coast. In reality, there is always wave energy propagating toward an exposed coast such as Virginia Beach.

## Wave climate

The 10-year time history from 1990 to 1999 for WIS Station 197 was reviewed and summarized using the program NEMOS (Nearshore Evolution Modeling System), a part of the CEDAS (Coastal Engineering Design and Analysis System). The Web page for the CEDAS is located at <http://chl.erd.c.usace.army.mil/cedas>.

Figure 7 is a percent occurrence histogram of wave direction, period, and height. Direction bands are 10 deg increments from 22 deg to 132 deg, equivalent to  $\pm 50$  deg on either side of the normal to the shore. Waves approaching the coast from directions outside this arc are not a significant consideration because they will be refracted greatly and reduced in height before breaking at the shore. Approximately 4.1 percent of the waves occur below 22 deg and 8.3 percent above 132 deg. The most common direction band, with 12.2 percent of the cases, is between 72 to 82 deg, with a mean of 76.3 deg, approximately perpendicular to shore. The middle numbers listed in each band are the averages or means for the band. Wave periods range from 1 to 23 sec, with 2-sec bands. The most commonly occurring wave period band, with 39.9 percent of the cases, is 3 to 5 sec. The overall mean peak wave period is 6.7 sec. The standard deviation of wave period is 3 sec.

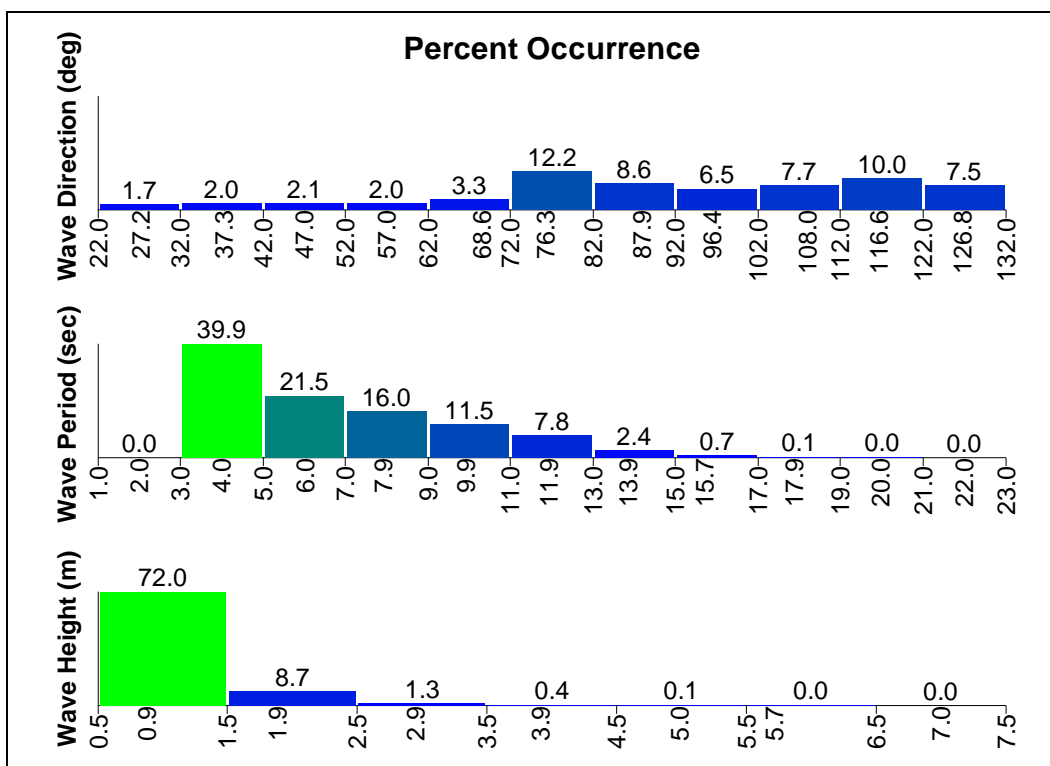


Figure 7. Percent occurrence histogram of wave direction, period, and height for Station 197, 1990 to 1999

Significant wave heights are shown from 0.5 to 7.5 m, in seven bands of 1 m bandwidth. Approximately 17.5 percent of the waves have heights less than 0.5 m. These were not considered in the analysis since they are below the threshold for significant sediment transport. Seventy-two percent of the cases fall in the 0.5-m to 1.5-m band. Overall mean significant height is 0.9 m, with a standard deviation of 0.6 m. The highest significant wave height is 5.8 m, with corresponding peak period of 12.3 sec and direction of 88 deg azimuth.

Figure 8 shows a significant wave height rose diagram. The concentric rings represent percent occurrence of up to 9 percent. Thicker bars represent smaller wave heights, as indicated in the legend. Wave directions are directions from which the waves are traveling, the same as meteorological conventions. A wave period rose is shown in Figure 9. Concentric rings represent up to 12 percent occurrence. Thicker bars represent smaller wave periods. The difference in percentage scales for the two rose diagrams is due to the filtering of the data to include only the ranges of wave period, height, and direction listed above.

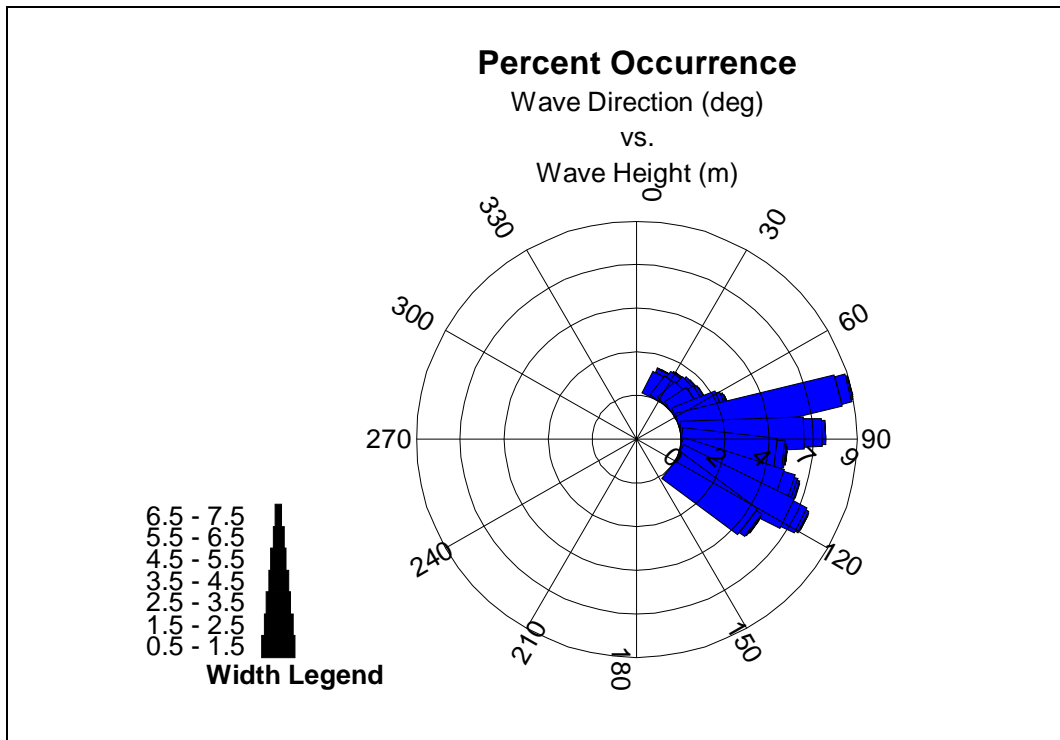


Figure 8. Wave height rose, WIS Station 197, 1990 to 1999.

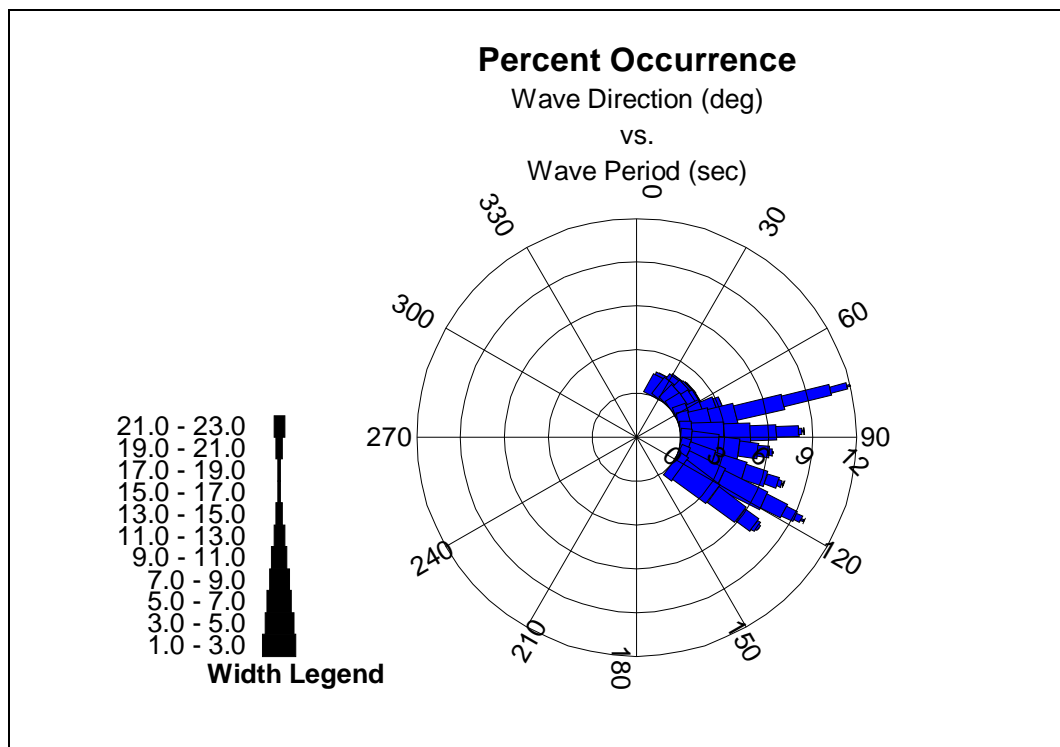


Figure 9. Wave period rose, WIS Station 197, 1990 to 1999.

## 3 Numerical Model

### Objectives and approach

The numerical model studies had two main objectives:

1. Develop the numerical model application to represent the study area adequately.
2. Use the numerical model to estimate wave conditions and littoral transport along Virginia Beach with existing and Plan 1 excavated offshore bathymetry in the Cape Henry borrow area.

The numerical model used for the study, STWAVE, is the standard CHL tool for studies of wave transformation over broad areas of complex, shallow nearshore bathymetry. The wave transformation model is described in the following section, including a general description of the STWAVE model and implementation of the model for the Virginia Beach study.

As part of the study procedures, a suite of incident wave conditions must be specified at the seaward boundary of the area covered by STWAVE. Incident waves are determined by consideration of the hindcast wave climate seaward of the study area. This setup for STWAVE and the type of output produced is described in the section on “Nearshore wave transformation.”

The final section of this chapter describes the study approach for estimating littoral transport rates and quantities. STWAVE transformation results are used to first estimate breaking wave conditions along the coast. Then, breaking wave information is fed into the calculation of potential longshore transport rates.

### Model description

#### Wave model

The numerical wave model STWAVE is a steady-state, finite-difference model used in the calculation of wave growth and transformation (Smith et al. 2001). Typically, the model area covers a rectangular domain with maximum dimension of about 26 nm or less, including regions with

complex, shallow water depths. Typical model grid resolution is 200 m (600 ft) or less. Recently, the model has been extended to include a capability for using a large-area, coarse grid to feed into a smaller-area fine grid (Smith and Smith 2002). This nesting capability can be helpful for near-shore wave transformation studies, but it was not considered necessary for the present study.

The STWAVE model is interfaced with commercially available Corps of Engineers-supported software to assist in preparing model grids and other inputs and in displaying model results. This software-assisted pre- and post-processing is needed in any practical application.

More information on STWAVE is available through the CHL Internet Web site at: <http://chl.erd.c.usace.army.mil/chl>. The software package for pre- and post-processing is part of the Surface-Water Modeling System (SMS). More information on SMS software is available through the STWAVE model Web site.

### **Grids**

The WIS information from Station 197 was used to characterize the offshore wave climate. Station 197 is approximately 21 km (11.3 nm) from the Virginia Beach coast, in nominal water depth of 17 m (56 ft). The STWAVE model was configured to estimate wave transformation between Station 197 and the Virginia Beach coast.

The National Oceanic and Atmospheric Administration (NOAA), National Geophysical Data Center (NGDC), 3-arc-second Coastal Relief Model database provided existing bathymetry for a large coastal area, including the study area. This bathymetric database is more fully described at Internet address <http://www.ngdc.noaa.gov/mgg/coastal/coastal.html>. This digital bathymetry was input to the SMS.

The numerical model domain is a rectangle. For this study, the rectangular boundary was aligned approximately parallel to the Virginia Beach coastline (Figure 5). The model offshore boundary was extended seaward far enough to encompass the most relevant shallow areas and shoal features seaward of the Virginia Beach coast and outside the entrance to Chesapeake Bay. Lateral boundaries were extended well past the study area to accommodate the range of incident wave directions affecting the study area. The south lateral boundary nearly reaches False Cape, Virginia, and

the north boundary falls near the tip of Cape Charles, on the north side of the Chesapeake Bay entrance. The model domain extends 15 km (8 nm) in the offshore direction and 47 km (25 nm) alongshore. Water depth along the seaward grid boundary is about 11–17 m (35–55 ft).

A finite-difference grid for STWAVE was constructed over the model domain using SMS. Parameters for creating the grid in SMS are given in Table 1. Resolution is 50 m (164 ft), which has sufficed in previous, similar studies and is reasonable relative to the 3-sec (92.5-m or 304-ft) resolution of the NGDC bathymetric database. The grid was built in the State Plane coordinate system (Horizontal System: State Plane NAD 83 [US] and State Plane Zone: Virginia South – 4502, Vertical System: NAVD 88 [US]) in units of meters, as required for STWAVE modeling. Model bathymetry for the existing bathymetry grid in the study area is shown in Figures 3 and 5.

**Table 1. Specifications for STWAVE grids.**

Parameter	Value
Cell size	50 m (164 ft)
Origin x (state plane)	3,734,096 m (12,250,934 ft)
Origin y (state plane)	1,086,681 m (3,565,215 ft)
Angle of rotation	193 deg
Length x	15,000 m (49,212 ft)
Length y	47,000 m (154,199 ft)
Number of cells	282,000
Number of land cells	11,310
Number of ocean cells	270,690
No. of I's (columns)	300
No. of J's (rows)	940

The grid with existing bathymetry was modified to include the proposed borrow area excavations to a uniform depth of 4.3 m (14 ft) below the existing bottom over an area of approximately 66M sq ft (Figure 4). The location and depth of excavation to be modeled were specified by CENAO to represent anticipated borrow activities over a 50-year time period.

The STWAVE model coverage area is typical of a relatively large regional wave transformation study. The possibility of extending the seaward boundary further seaward or nesting the nearshore grid into a



large-domain, coarse resolution offshore grid was considered. Advantages would include encompassing more of the irregular bathymetry on the wide continental shelf along the study coast and reaching out to the WIS station used for incident wave conditions. The grid would need to extend seaward another 6.3 km (3.5 nm) to reach the WIS station and considerably further to encompass irregular bottom features. The computational load and complications associated with such an effort did not seem warranted in the present study, in part because bottom depth changes within 9–13 nm seaward of the grid boundary are relatively mild and disorganized.

The STWAVE model cannot simulate waves coming from directions that are highly oblique to the grid orientation, because STWAVE is a half-plane model (i.e., only considers a 180 deg window of incident energy). When mean wave directions exceed about 60 deg (for typical directional spreading), energy is “lost” owing to the half-plane assumption. Thus, model grid orientation was selected to minimize the occurrence of highly oblique wave angles in regions of interest.

The range of directions in the incident wave climate is greater than can be modeled effectively by a single STWAVE grid. However, in studies focused on nearshore concerns, such as longshore sediment transport as in the present study, a single grid can suffice, since highly oblique offshore waves would be greatly refracted and attenuated by natural processes before arriving at the study site.

## **Nearshore wave transformation**

### **Incident wave conditions**

A range of wind wave and swell conditions incident to Virginia Beach was considered in STWAVE modeling. A representative range of significant wave heights, peak wave periods, and mean wave directions that are a concern at the coast was included, based on the hindcast wave climate. The wave parameters modeled are given in Table 2. Every combination of the three wave parameters was modeled in STWAVE, giving a total of 495 wave conditions (5 heights  $\times$  9 periods  $\times$  11 directions). These conditions provide reasonable coverage of the wave climate. Directions were chosen to cover the full directional exposure of the coast, in 10-deg increments.

Table 2. Directional spectral wave parameters.

Parameter	No.	Units	Values
Wave period	9	sec	4, 6, 8, 10, 12, 14, 16, 18, 20
Wave height	5	m	1, 2, 3, 4, 5
Wave direction	11	deg	27, 37, 47, 57, 67, 77, 87, 97, 107, 117, 127

For each STWAVE input height/period/direction combination, SMS was used to generate a directional wave spectrum in water depth appropriate to the grid seaward boundary (16 m or 52 ft). Spectral frequencies ranged from 0.04 Hz to 0.33 Hz in 0.01-Hz intervals to cover frequencies corresponding to one-half to three-times the peak frequency. Spectral direction components covered  $\pm 85$  deg from normal incidence to the grid, in 5-deg increments. The directional spectrum consists of a Texel Marsden Arsloe (TMA) frequency spectrum and a  $\text{Cos}^n$  spreading function. Spectral wave parameters were selected for each wave based on wave period, a standard approach for practical CHL studies. For the TMA spectrum, frequency spreading is a function of the  $\gamma$  parameter that varied between 3.3 (broad) to 8 (narrow). For the directional  $\text{Cos}^n$  spreading function, the “n” parameter ranged from 4 (broad) to 30 (narrow). These spectra formed the incident wave input for STWAVE nearshore transformation simulations. A listing of all parameters used for each of the 45 height-period cases is contained in Appendix A.

One water level was used for all simulations, corresponding to the mean lower low water (MLLW). NOAA National Ocean Service data for the National Tidal Datum Epoch (1983–2001) were examined for stations near the study area. The Rudee Inlet Station, which is representative of the study area, shows a difference between mean sea level (MSL) and MLLW of only 0.56 m (1.8 ft). MLLW was chosen for simulations to insure that possible impacts of the offshore borrow area would be evident. The overall effect of the borrow pit on longshore transport may be slightly amplified in the study owing to the choice of water level.

### **STWAVE output**

The main output from STWAVE runs consists of two types of information. Wave field or “wav” files of significant wave height, peak period, and peak direction over the grid are produced first for each incident wave case. These relatively large files are useful for visualizing wave transformation over the entire grid. Second, height/period/direction information is saved

as “selhts” files at selected monitoring stations in the grid, providing another, much more condensed output. Station output in shallow water along the coast was needed for this study, as discussed in the following sections.

## **Littoral transport**

The approach to estimating potential littoral transport was to: (a) use STWAVE results to create a 10-year time history of near-breaking wave parameters at each nearshore station; (b) transform the near-breaking waves to a point at which breaking begins, using the assumption of locally, straight, parallel bottom contours; and (c) compute potential longshore transport rate from that breaking wave height and angle. With consideration of the 10-year incident wave time history, annual potential transport rates can then be calculated. Details of the approach are given in the following paragraphs.

### **Wave time history at nearshore monitoring stations**

Monitoring stations for saving STWAVE wave parameters to be used in littoral transport estimation were selected with two primary objectives. First, the stations should be shoreward of all significant effects of irregular bathymetry (including proposed project-related changes in bathymetry), so that STWAVE will have included these effects in wave transformation. Second, stations should be seaward of the nearshore surf zone, so that STWAVE has not yet invoked breaking limits on wave height and the breaking wave height and angle needed for calculating longshore transport rates can be estimated accurately.

A nearshore monitoring station was selected for every alongshore grid cell adjacent to study area beaches. Stations were placed around the 6 m (20 ft) contour, where bottom contours were reasonably parallel to the shoreline. The selection of the 6-m contour is not exact, so including the larger 5-m wave height cases even though they might have experienced some breaking offshore from this location was felt to be satisfactory. Station 1 was located south of Rudee Inlet and Station 236 was positioned near 89th Street (Figure 10). The distance between stations is 50 m, the same as the STWAVE grid spacing. Table 3 lists the “i” and “j” indices corresponding to the STWAVE grid cell locations for each of the major stations. Thus, Stations 35 through 236 cover the study area.

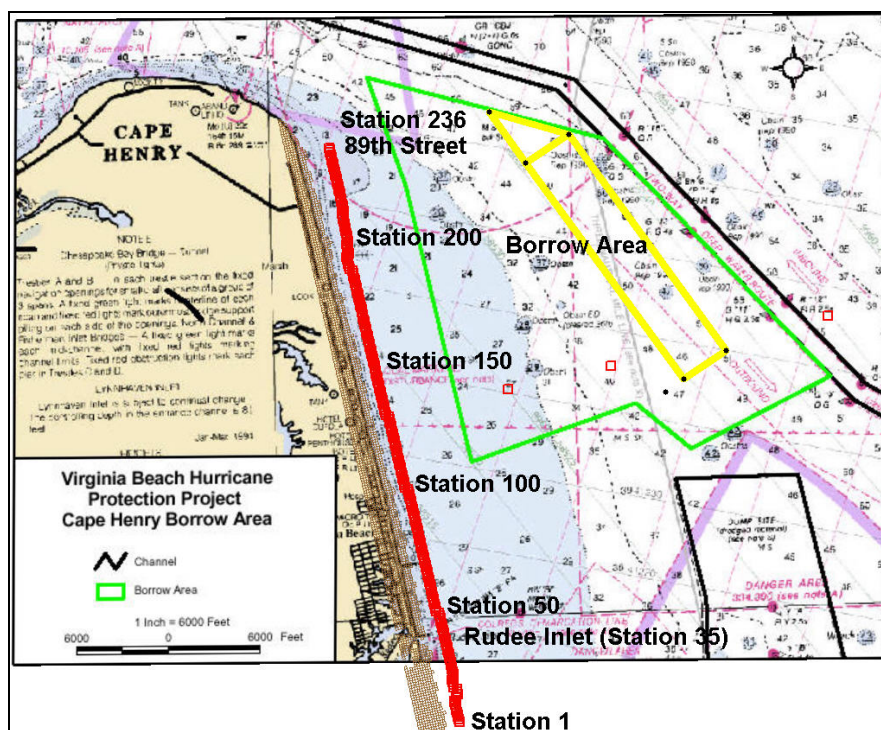


Figure 10. Monitoring station locations relative to Cape Henry borrow area.

Table 3. Monitoring station STWAVE location coordinates.

Station No.	STWAVE i	STWAVE j	Comment
1	284	555	Beginning station
35	282	521	Rudee Inlet
50	283	506	
100	284	456	
150	285	406	
200	284	356	
236	283	320	89th Street

Stations 1 through 34, south of Rudee Inlet, were included to provide some overlap with previous studies focused on the coast south of Rudee Inlet (e.g., Kelley et al. 2001).

Results at nearshore monitoring stations from the 495 STWAVE runs were used to transform the WIS 10-year time history of offshore waves into a 10-year time history of nearshore waves at each station via a post-processing program called VaBeach\_Timehist. The procedure consisted of the following basic steps:

- compute the ratio of significant wave height parameter at each monitoring station to incident wave height for every station and every incident wave condition run in STWAVE;
- compute similar ratios for peak period and direction parameters;
- associate each wave case in the 10-year WIS time history with the STWAVE run which most nearly matches the incident wave parameters; and
- apply (i.e., multiply) the transformation ratios from STWAVE to each WIS wave case to create a 10-year time history at each nearshore station.

### Calculation of breaking wave conditions

A “shoreline” angle was specified for each nearshore station to establish the orientation of the straight, parallel bottom contours to be used in calculating wave breaking conditions. An average shoreline angle of 77 deg azimuth was estimated from available charts (Chart #12221, Chesapeake Bay Entrance). This approximation fits well for the study area, which consists of a nearly straight coastline and exceptionally straight, parallel bottom contours between the nearshore monitoring stations (about 6-m depth) and the point at which waves will break.

A computer program, VaBeach\_QCalc, was adapted from previous studies to iteratively calculate breaking wave heights and angles. Inputs to the program include nearshore station 10-year time history and shoreline angles. The breaking criterion (for monochromatic waves) used was  $H_B = 0.78 d$ , where  $d$  = water depth.

### Calculation of longshore transport rates

Potential longshore transport rates are also calculated in program VaBeach\_Qcalc. The 10-year time history of breaking waves at each nearshore monitoring station is used to calculate a corresponding time history of hourly potential longshore transport rate at each station. Potential longshore transport rates  $Q$  are calculated as

$$Q = KH_B^{2.5} \sin(2\alpha_B) \quad (1)$$

where:

$K$  = constant

$\alpha_B$  = breaking wave angle relative to bottom contours.

When  $H_B$  is in meters and  $Q$  in  $\text{m}^3/\text{day}$ , the generally accepted value of  $K$  is 5,100 (Equation 6-7b of USACE 1992). Program calculations were done in metric units with  $Q$  expressed in  $\text{m}^3/\text{sec}$ . The corresponding constant is  $K = 0.0590$ . The equivalent  $K = 0.0772$  for engineering units of  $\text{cu yd}/\text{yr}$  when  $H_B$  is expressed in units of feet.

In recent past studies along the U.S. Atlantic Coast using the same modeling approach as in this study, longshore transport rates produced by the above equation were unreasonably large (Thompson et al. 1999; Cialone and Thompson 2000). Calibration to documented longshore transport produced a value of  $K = 0.023$  in both studies. That value was also used in this study, producing longshore transport estimates consistent with available information, as is discussed in Chapter 5.

Following standard convention, longshore transport directed to the right of an observer on the beach facing the ocean is positive (southward transport in this study), and transport toward the left is negative (northward transport in this study).

Contributions during each year in the time history of wave conditions are combined to give annual north and south potential longshore transport rates. Net potential longshore transport rates are determined as the sum of north and south magnitude rates, since northward transport is negative. Gross potential longshore transport rates are the combined absolute magnitudes of north and south transport rates. Annual longshore transport rates from all 10 years of wave information can be combined to give average annual rates and standard deviations, which provide a helpful measure of expected variability between years.

## 4 Wave Transformation

The objective of this chapter is to present model results showing the influence of nearshore bathymetry on wave transformation and the impact of the deepened borrow area on wave patterns in Plan 1. The presentation is focused on a representative sample of the most commonly occurring wave conditions. These conditions illustrate key nearshore wave transformation effects and help explain the relative changes in potential longshore transport presented in Chapter 5.

### Wave transformation examples for existing and Plan 1 bathymetry

Six of the 495 incident wave events were chosen to illustrate wave transformation patterns (Table 4). These six events include two wave periods and three wave directions for a significant wave height of 1 m. The 1-m significant height is approximately equal to the mean significant height at Virginia Beach. The two wave periods are representative of sea and swell waves during storms. The 77-deg wave direction is perpendicular to shore and the other two directions are 40 deg north and south of shore-perpendicular.

Table 4. Wave transformation events.

Event	Height, m	Period, sec	Direction, deg
1	1.0	8	37
2			77
3			117
4	1.0	12	37
5			77
6			117

Figures 11 through 16 illustrate wave transformation and differences in wave heights between Plan 1 and existing bathymetries for the six events. The top plot in each figure shows wave transformation over the existing bathymetry. The bottom plot is the difference in wave heights between the modified Plan 1 (P1) with the borrow pit and the existing (Ex) bathymetry (i.e.,  $P1 - Ex$ ). For the wave transformation plot, contours range from 0 to 1.2 m, with a contour interval of 0.05 m. For the wave height differences plot, contours range from -0.16 to 0.12 m, with a contour interval of

0.02 m. The monitoring stations and annotation about relative locations are listed on each figure. The borrow area is shown in yellow or green (depending on the background color to improve readability) on both plots for reference.

Figure 11a is for Event 1 with  $T_p = 8$  sec,  $H_s = 1$  m, and waves from the northeast (i.e.,  $\bar{\theta} = 37$  deg). Waves in the vicinity of the Cape Henry borrow area are generally smaller than the incident 1-m wave height. Significant wave refraction does not occur until the waves are closer to shore, well shoreward of the borrow area. Wave heights in the nearshore area for this event are lower generally than for the other events. Figure 11b shows the difference in wave heights between Plan 1 and existing bathymetry for Event 1. Positive values indicate that the Plan 1 wave heights are higher than existing bathymetry heights for this case. Green areas are predominant, indicating no significant change. Differences range from -0.05 to 0.04 m, a very small change in wave heights resulting from Plan 1. Although not shown within the scale of Figure 11b, waves are slightly higher within the borrow area and present a “fan-shaped” area north and south of the borrow area. There is a slight decrease in wave height at the southerly end of the borrow area. Thus, Plan 1 bathymetry results in a shadow area of slightly lower wave heights on the lee side of the borrow area. The shadow extends all the way to the coast.

Figures 12a and 12b are for Event 2, with  $T_p = 8$  sec,  $H_s = 1$  m, and wave direction perpendicular to the beach (i.e.,  $\bar{\theta} = 77$  deg). In general, wave heights for this wave direction are the highest for the three wave directions, with the predominant values greater than 0.95 m (Figure 12a). There is a noticeable increase in wave height northeast of the borrow area. Shoals north of the navigation channel cause this wave increase. Figure 12b illustrates differences in wave heights for Event 2. Wave height differences range from -0.05 to 0.06 m, similar to Event 1. The Plan 1 wave heights tend to be slightly higher inside and north of the borrow area. They are slightly lower to the south and in a large shadow area to the west of the borrow area.



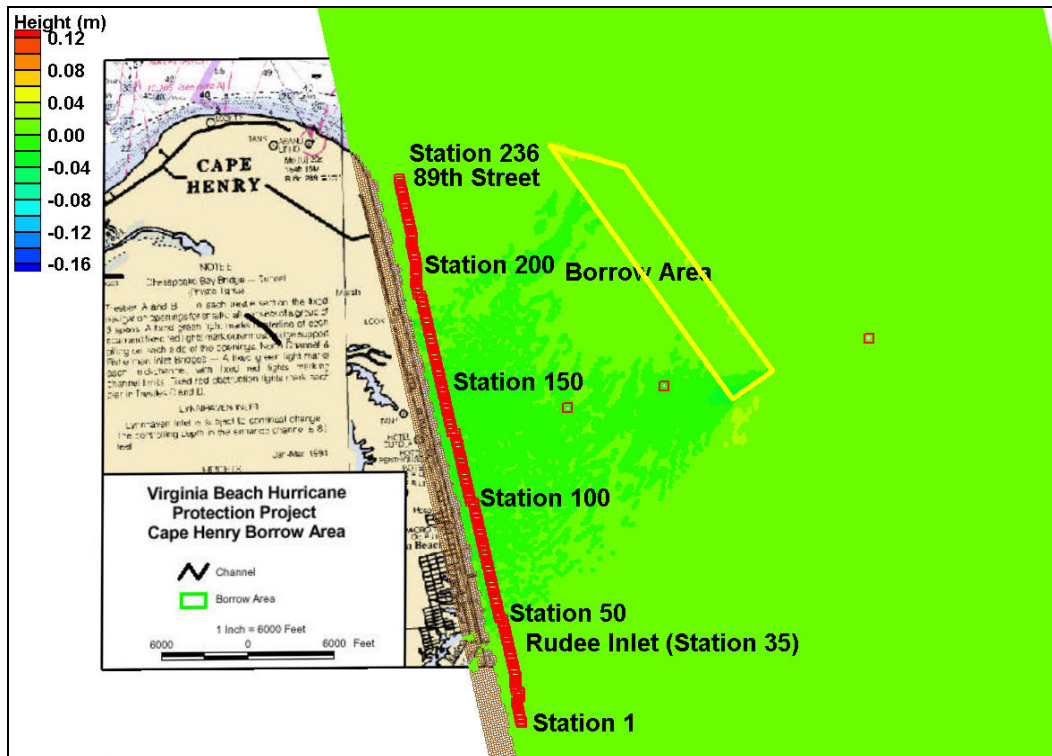


Figure 11a. Wave transformation for existing bathymetry and Event 1:  $T_p = 8$  sec,  $H_s = 1$  m, Dir = 37 deg.

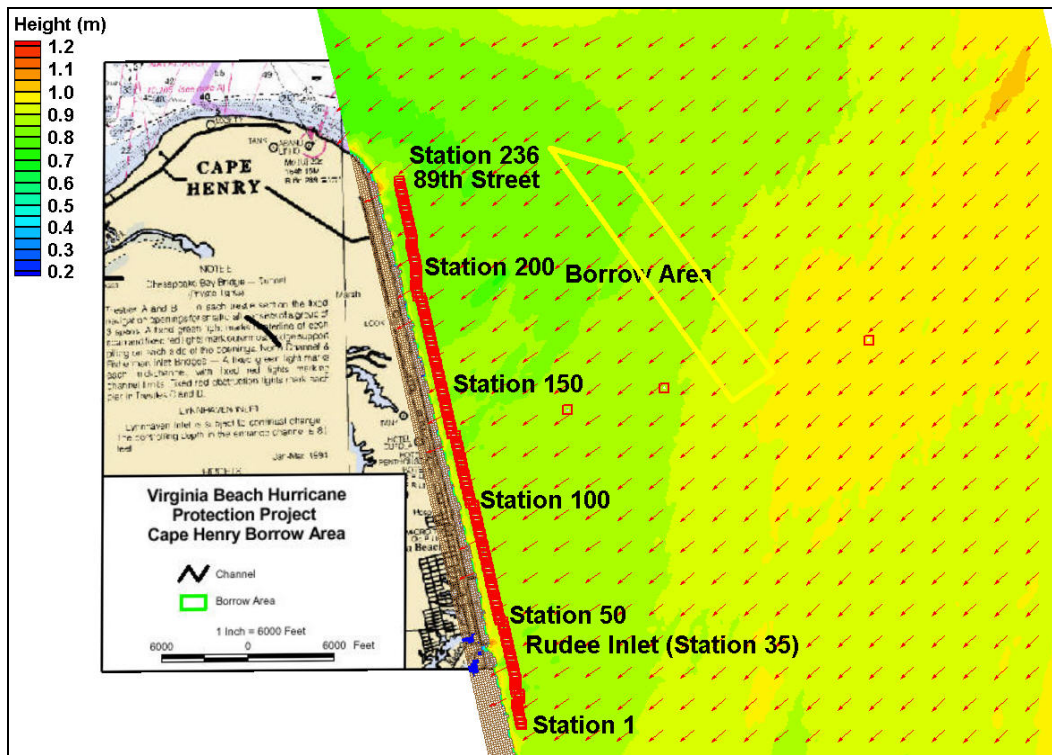


Figure 11b. Difference in wave height between Plan 1 with borrow area and existing bathymetry for Event 1:  $T_p = 8$  sec,  $H_s = 1$  m, Dir = 37 deg.

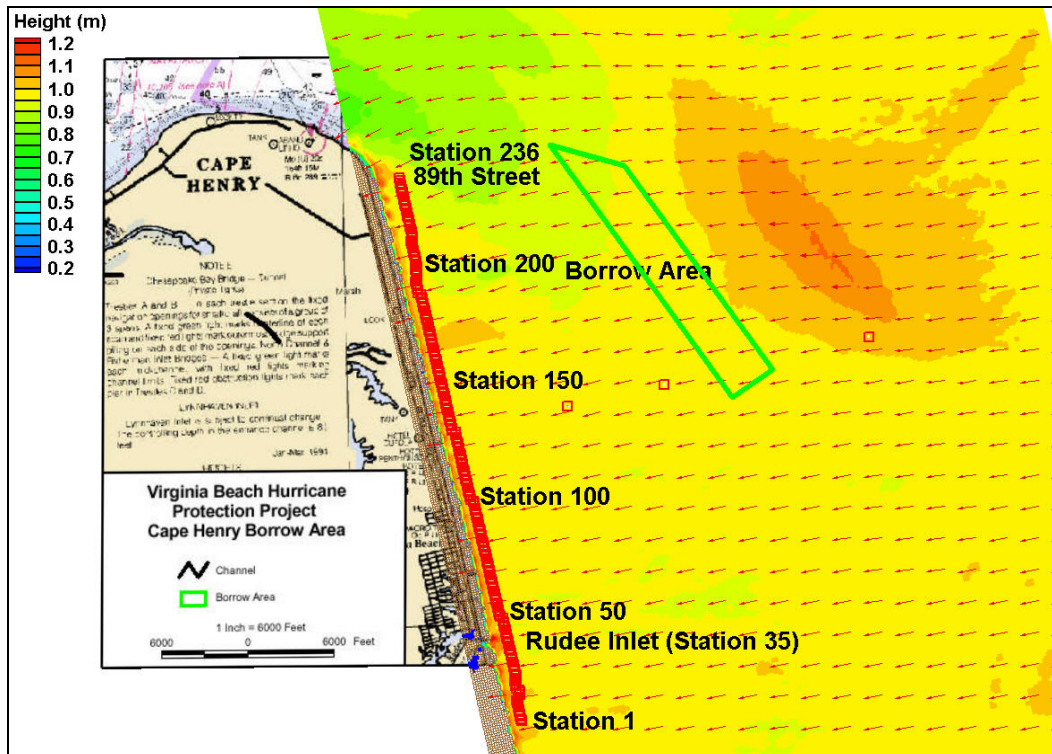


Figure 12a. Wave transformation for existing bathymetry and Event 2:  $T_p = 8$  sec,  $H_s = 1$  m, Dir = 77 deg.

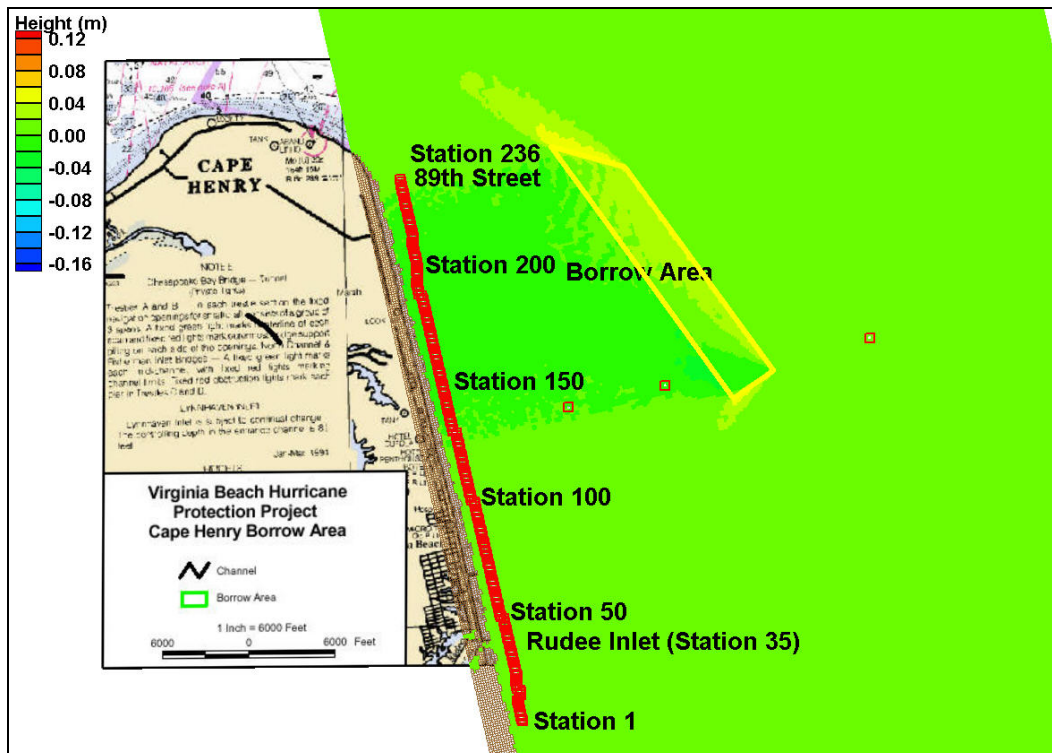


Figure 12b. Difference in wave height between Plan 1 with borrow area and existing bathymetry for Event 2:  $T_p = 8$  sec,  $H_s = 1$  m, Dir = 77 deg.

Figures 13a and 13b are for Event 3, with  $T_p = 8$  sec,  $H_s = 1$  m, and wave direction from the southeast (i.e.,  $\bar{\theta} = 117$  deg). In general, wave heights are divided about the borrow area and the navigation channel, with higher heights to the northeast and lower values southwest. Wave heights are higher than those from Event 1, but lower than those from Event 2. As for Event 2, there is a large area of shoaling (i.e., increased wave heights) just northeast of the borrow area and navigation channel. Wave height differences for this Event are shown in Figure 13b. In general, the existing bathymetry wave heights are higher than the Plan 1 values, with most of the contours ranging from  $-0.10$  to  $0.06$  m. The Plan 1 wave heights are higher than existing bathymetry at the northern end of the borrow area. The existing bathymetry wave heights are higher (i.e., negative differences) in the lee and to the west of the borrow area, projecting all the way to near Station 210 and north.

Figures 14–16 are for Events 4–6 with  $T_p = 12$  sec. The wave transformation patterns are similar for the  $T_p = 8$  sec cases, but wave height changes are more pronounced for the longer period events. This is caused by the longer period waves (with correspondingly longer wavelength) feeling the bottom and being modified by the bathymetry more strongly in the modeled area. The wave height difference plots also exhibit similar patterns as the  $T_p = 8$  sec cases. They are more intense, however, with larger differences between the Plan 1 and existing bathymetry cases.

### **Influence of borrow area on wave conditions at beaches north and south of Cape Henry borrow area**

The impact of the dredged borrow area on incident wave conditions can be evaluated by examining *changes* in wave height and direction at the near-shore monitoring stations along the 6-m contour. These *changes* correlate closely to potential littoral transport differences presented in Chapter 5.

#### **Wave heights**

Figures 17a and 17b show calculated wave heights for existing bathymetry and changes in wave height at the 236 monitoring stations for the six wave events (Table 4). The changes represent wave heights for Plan 1 with the borrow pit minus existing bathymetry values for each event. The nominal 1-m incident wave height leads to nearshore wave heights that may be interpreted directly as transformation functions and/or fractional changes caused by sheltering, refraction, and shoaling.

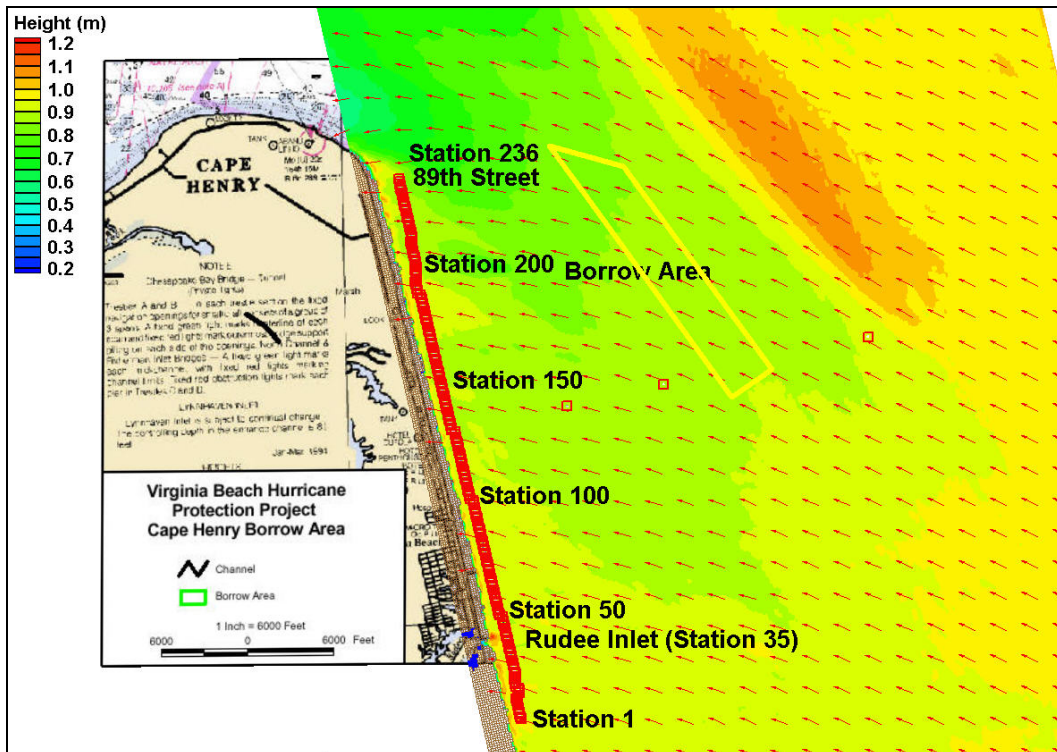


Figure 13a. Wave transformation for existing bathymetry and Event 3:  
 $T_p = 8$  sec,  $H_s = 1$  m, Dir = 117 deg.

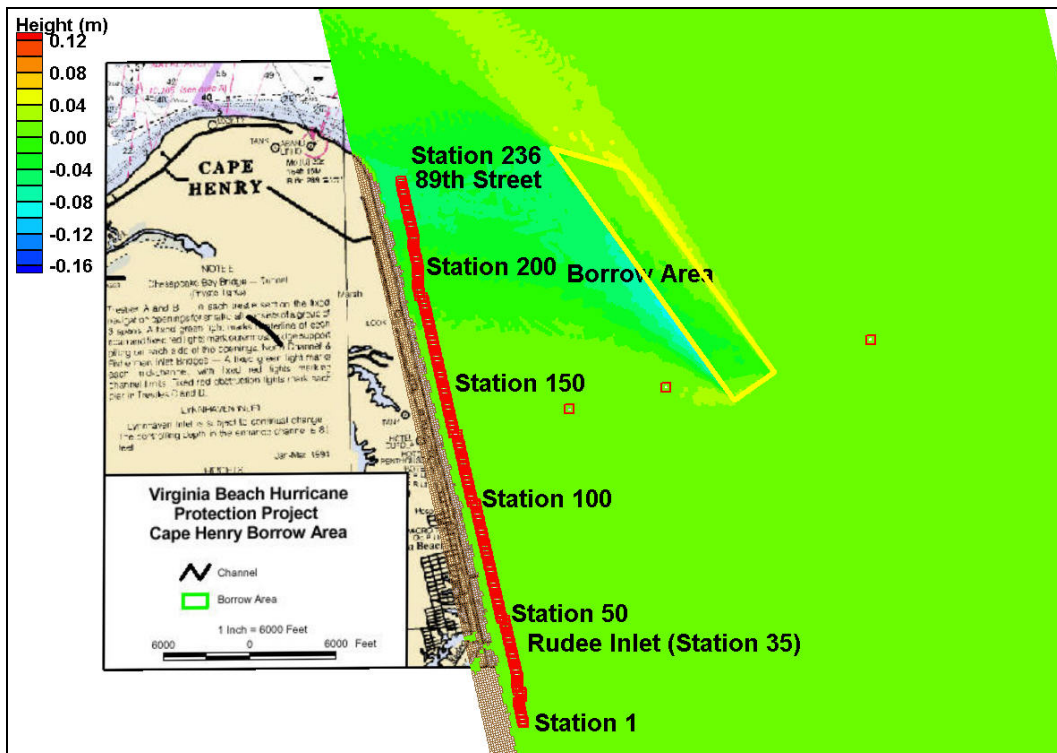


Figure 13b. Difference in wave height between Plan 1 with borrow area and existing bathymetry for Event 3:  $T_p = 8$  sec,  $H_s = 1$  m, Dir = 117 deg.

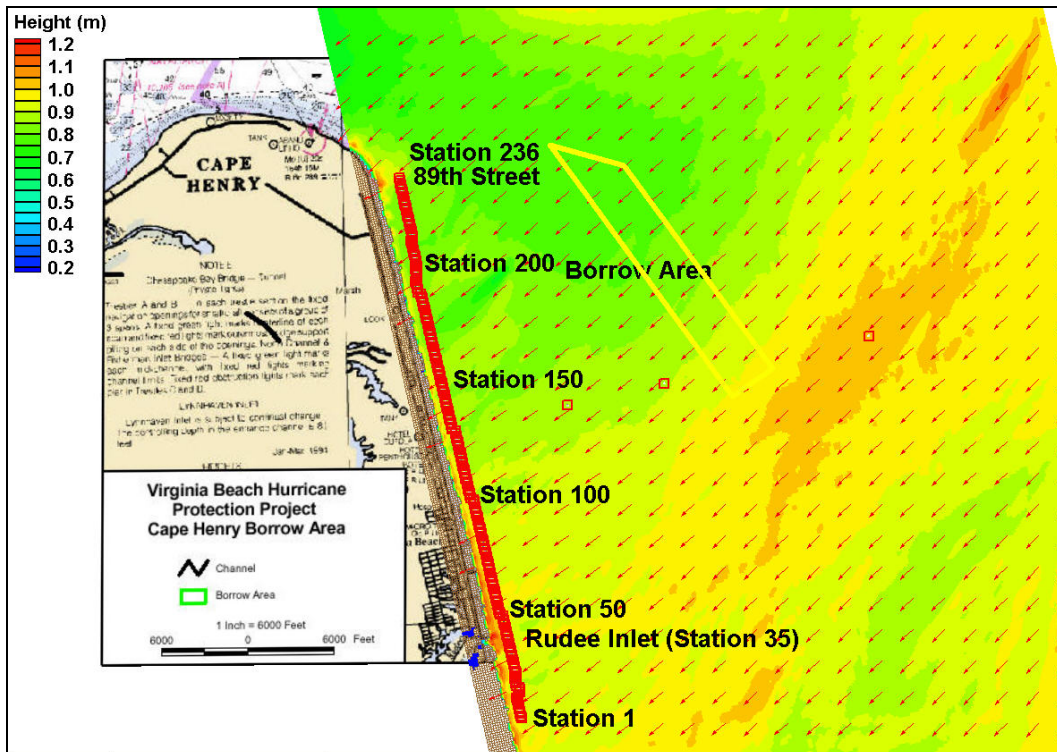


Figure 14a. Wave transformation for existing bathymetry and Event 4:  $T_p = 8$  sec,  $H_s = 1$  m, Dir = 37 deg.

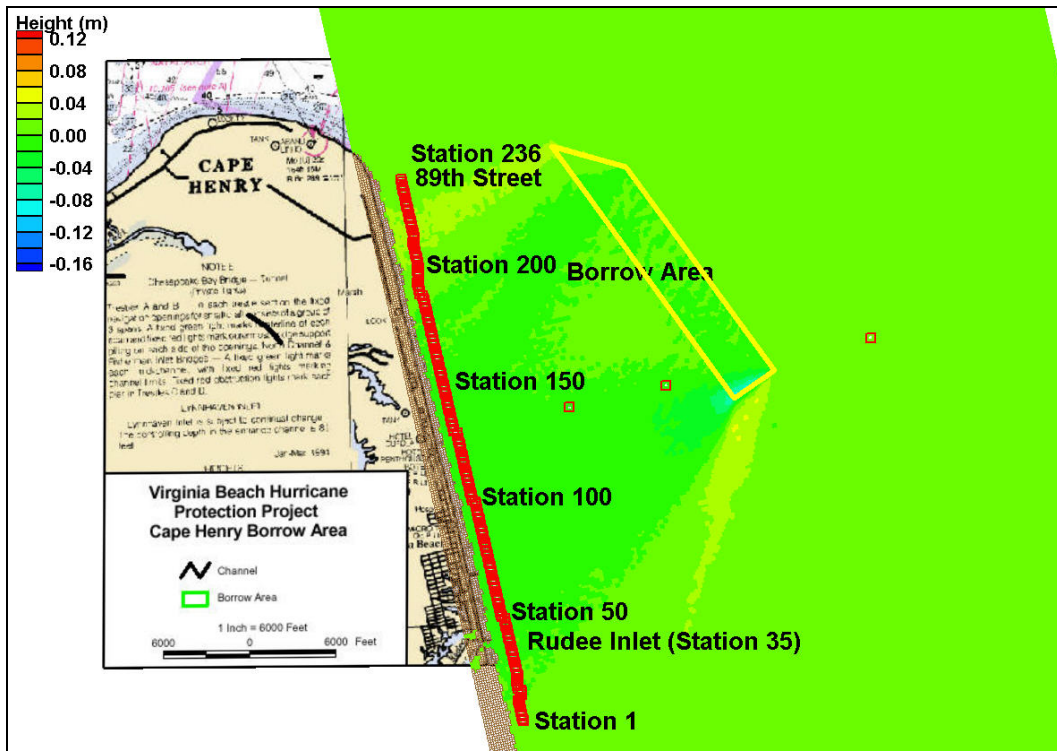


Figure 14b. Difference in wave height between Plan 1 with borrow area and existing bathymetry for Event 4:  $T_p = 8$  sec,  $H_s = 1$  m, Dir = 37 deg.

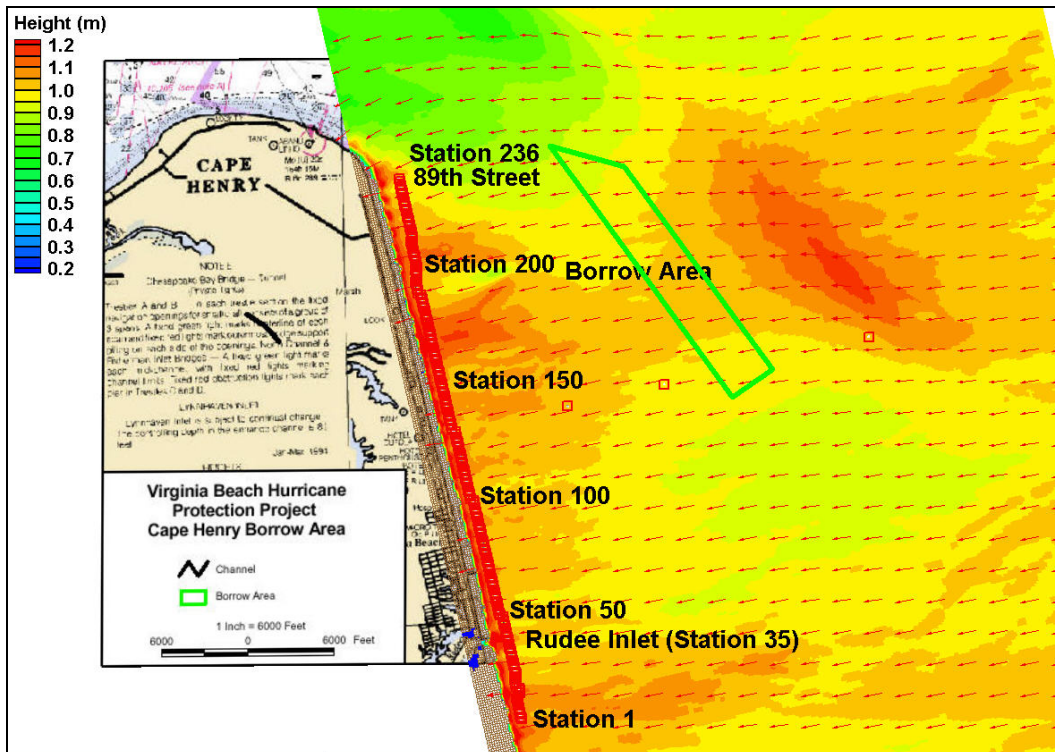


Figure 15a. Wave transformation for existing bathymetry and Event 5:  
 $T_p = 8$  sec,  $H_s = 1$  m, Dir = 77 deg.

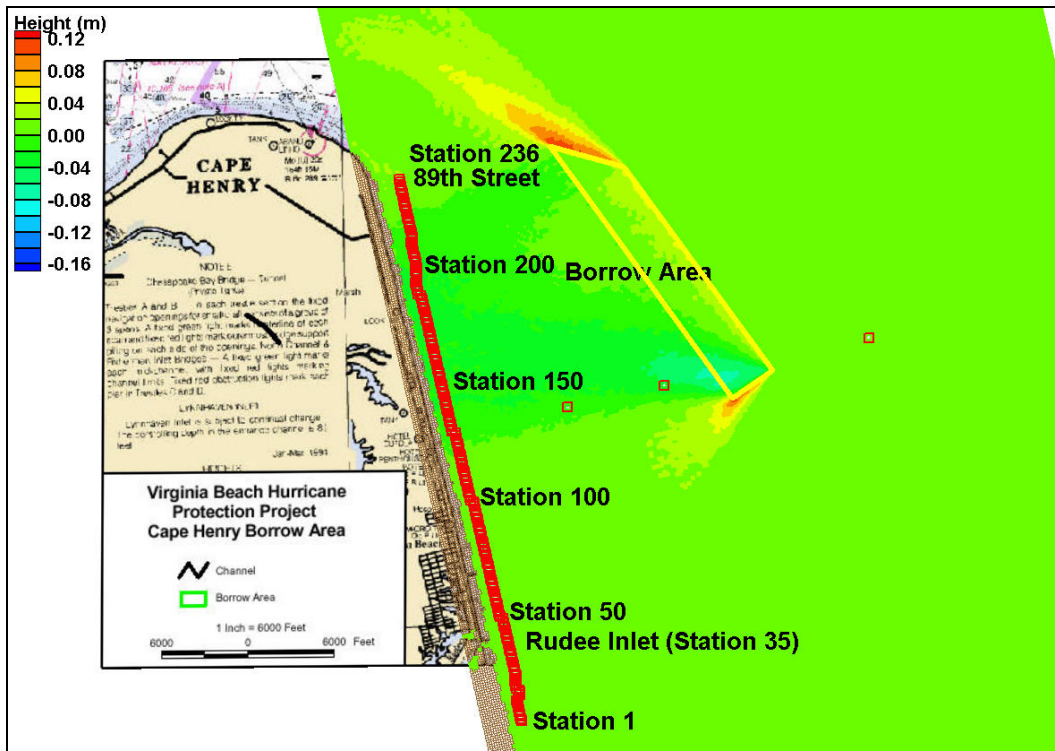


Figure 15b. Difference in wave height between Plan 1 with borrow area and existing bathymetry for Event 5:  $T_p = 8$  sec,  $H_s = 1$  m, Dir = 77 deg.

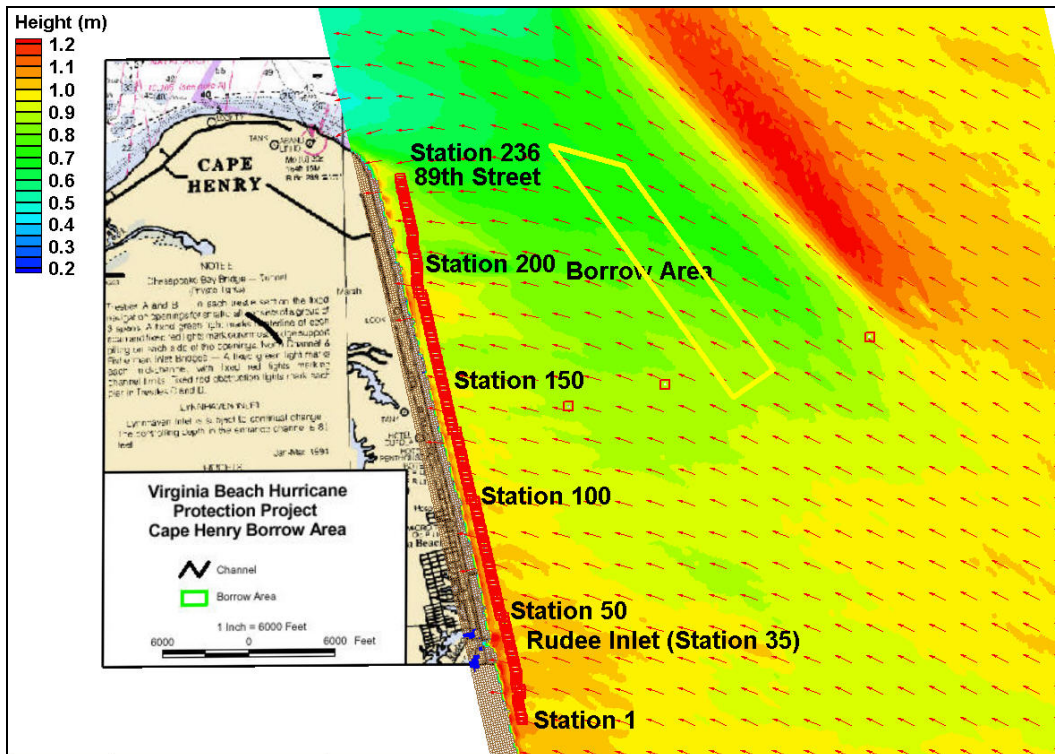


Figure 16a. Wave transformation for existing bathymetry and Event 6:  
 $T_p = 8$  sec,  $H_s = 1$  m, Dir = 117 deg.

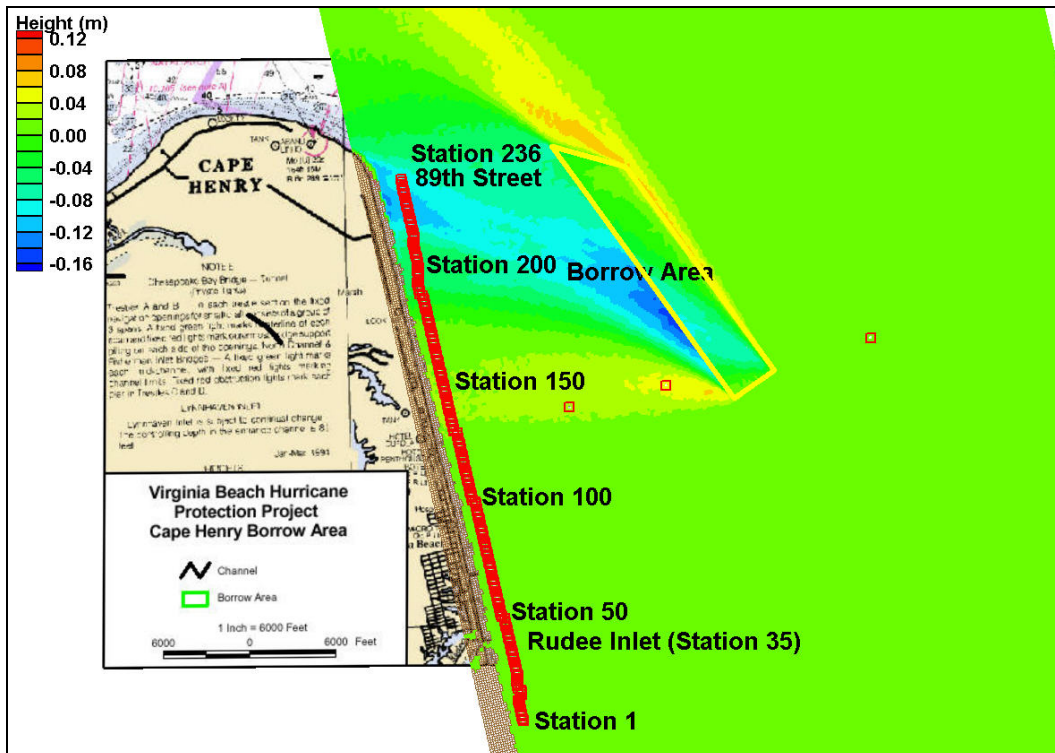


Figure 16b. Difference in wave height between Plan 1 with borrow area and existing bathymetry for Event 6:  $T_p = 8$  sec,  $H_s = 1$  m, Dir = 117 deg.

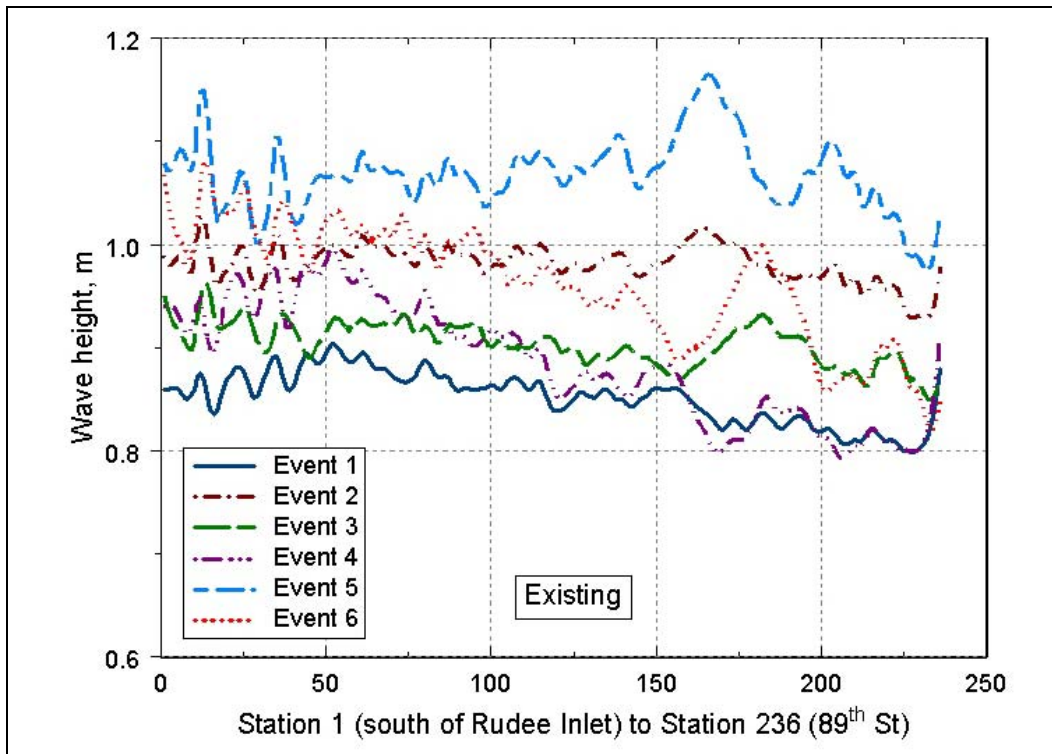


Figure 17a. Event wave height at monitoring stations, existing bathymetry.

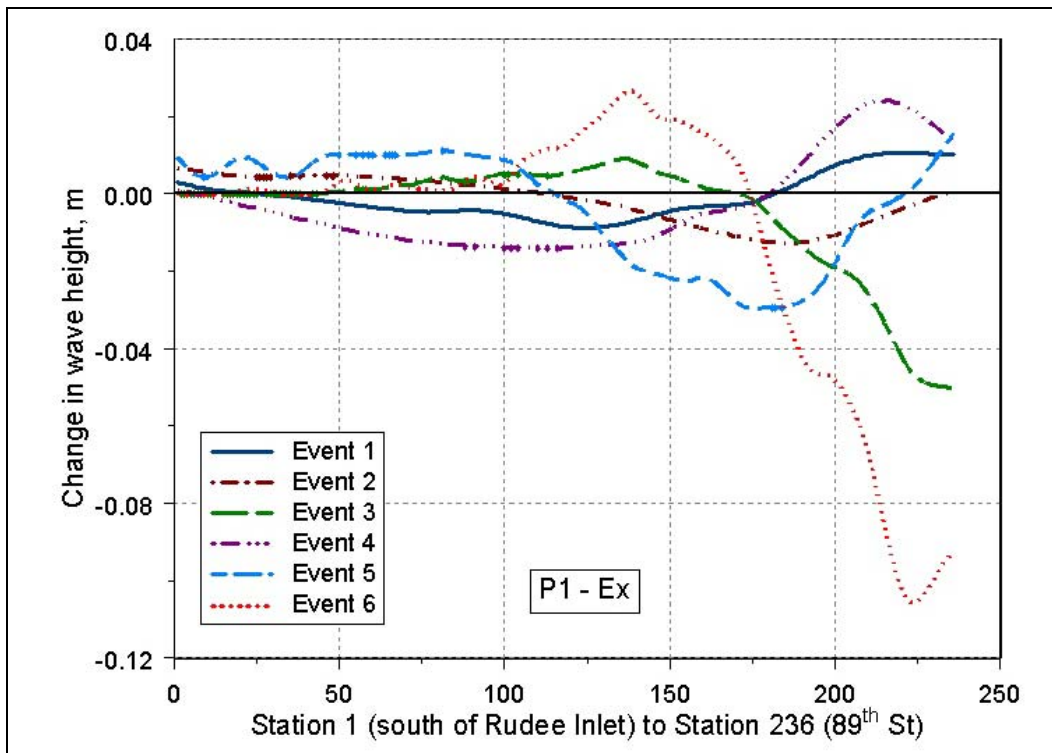


Figure 17b. Impact of borrow area on wave height at monitoring stations, Plan 1 - existing bathymetry.



Wave heights range from approximately 0.8 to 1.2 m for the six events (Figure 17a). In general for the existing bathymetry, Event 1 ( $T_p = 8$  sec,  $\bar{\theta} = 37$  deg) has the lowest wave heights and Event 5 ( $T_p = 12$  sec,  $\bar{\theta} = 77$  deg) the highest. Changes in wave height range from approximately  $-0.12$  to  $0.03$  m. Again, positive values indicate higher wave heights for the Plan 1 cases. In general, the wave heights are reduced by the proposed Plan 1 owing to the borrow area. Events 5 and 6 are affected significantly in this manner. Plan 1 heights are higher for Event 6 (i.e., positive increase) between about stations 100 to 174, however. These patterns were also evident in the previous figures of wave height and difference contours (Figures 11 to 16). The length of coast covered by the borrow area stretches roughly from Station 100 to 236 (perpendicular projections of the borrow area boundaries to shore). For the northeast (i.e.,  $\bar{\theta} = 37$  deg) cases, however, the effect of the borrow area can stretch all the way to Rudee Inlet at Station 35. The impact of the borrow area on the northern stations is stronger for the southeast cases (i.e.,  $\bar{\theta} = 117$  deg). In general, the amount of positive change in wave height is relatively small for Plan 1. Thus, wave height changes caused by the Plan 1 borrow area are relatively small, and in most cases are reduced. However, even small changes can impact longshore sediment transport significantly, since that is based on the breaking wave height raised to the power 2.5.

### Wave directions

Figures 18a and 18b illustrate wave direction for existing bathymetry and changes in wave direction at the 236 monitoring stations for the six wave events. In Figure 18a the curves are grouped by incident wave direction (i.e.,  $\bar{\theta} = 37, 77,$  and  $117$  deg) pairs for the two wave periods (i.e.,  $T_p = 8$  and  $12$  sec). Wave direction does not appear to be changed significantly by either wave period for the existing bathymetry. In general, wave direction decreases toward the north, becoming more southerly. Figure 18b shows the change in wave direction for the six events. The change in wave direction is defined as before, positive values indicate that Plan 1 values are larger than the existing bathymetry. Changes appear to be minor, varying from  $-1.5$  to  $1$  deg. The curves shown in the figure are curve fit to the data using a smoothing spline routine because of the small variation in the data.

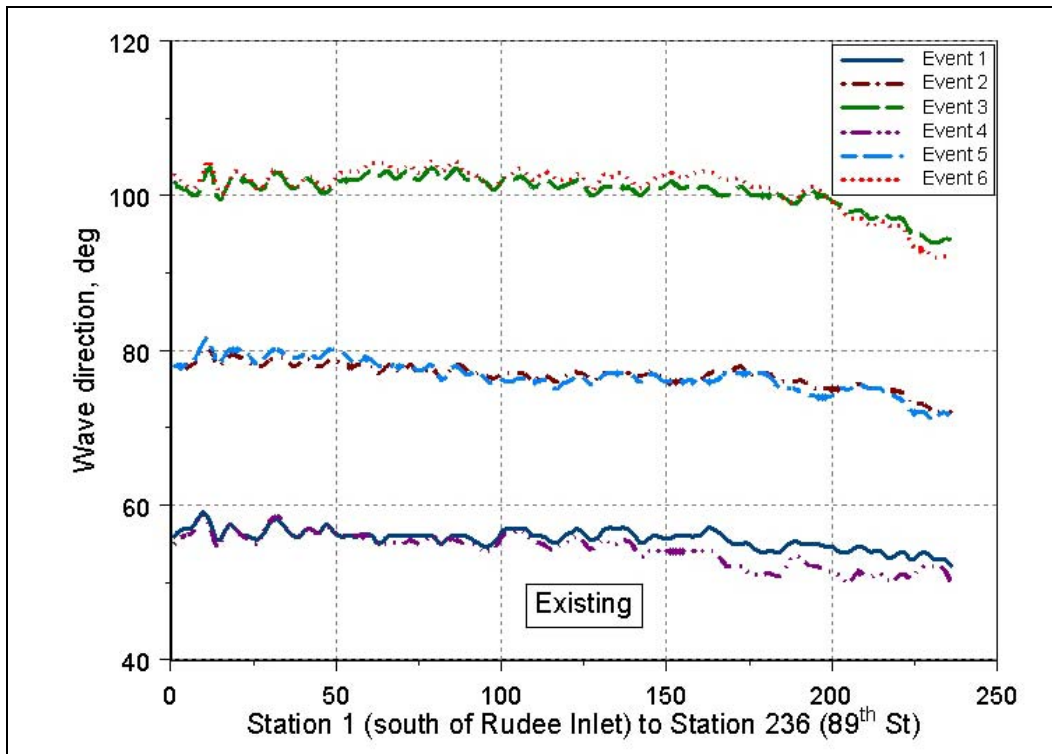


Figure 18a. Event wave direction at monitoring stations, existing bathymetry.

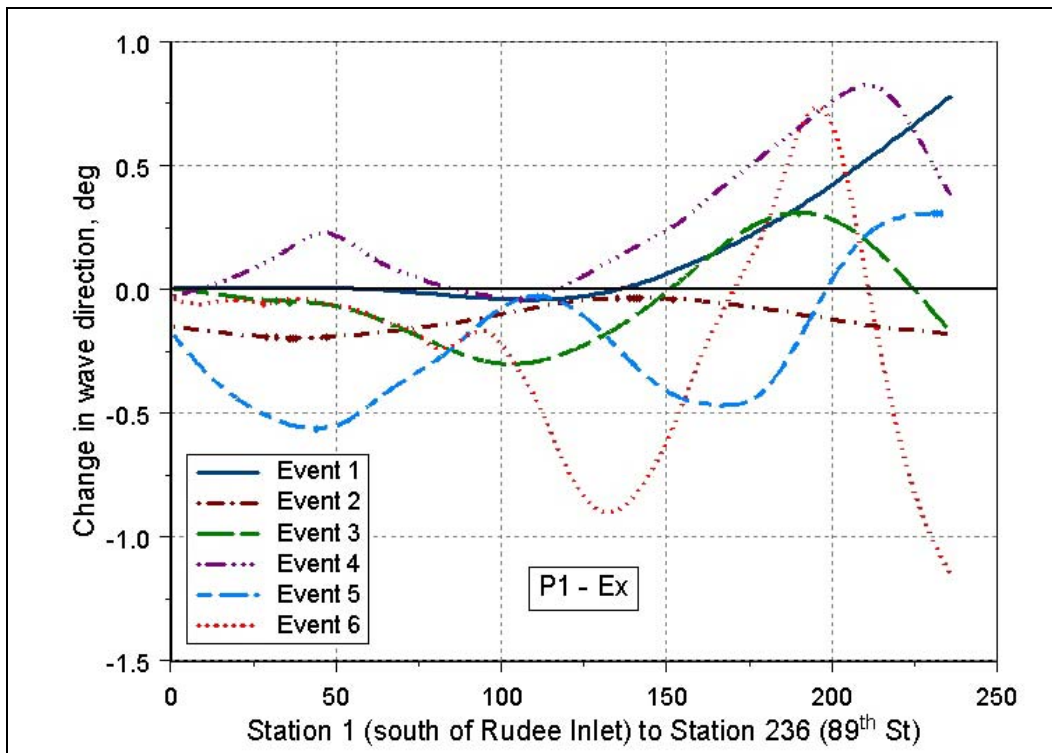


Figure 18b. Impact of borrow area on wave direction at monitoring stations, Plan 1 - existing bathymetry.

In summary, a predictor of potential littoral transport differences is to examine the changes in wave height and direction at the 236 monitoring stations. Wave heights range from approximately 0.8 to 1.2 m for the six events. In general for the existing bathymetry, Event 1 ( $T_p = 8$  sec,  $\bar{\theta} = 37$  deg) has the lowest wave heights and Event 5 ( $T_p = 12$  sec,  $\bar{\theta} = 77$  deg) the highest. Changes in wave height range from approximately  $-0.12$  to  $0.03$  m (positive values indicate higher wave heights for the Plan 1 cases). The impact of the borrow area on the northern stations is stronger for the southeast waves. In general, wave height changes resulting from Plan 1 are relatively small, and in most cases are reduced. Wave direction does not appear to be changed significantly by either wave period for the existing bathymetry. Differences in wave direction between existing and Plan 1 are insignificant (i.e., varying from  $-1.5$  to  $1$  deg). In general, wave direction decreases toward the north, becoming more southerly.

## 5 Littoral Transport Potential

The objective of this chapter is to present model simulations of potential longshore sediment transport, based on the 10-year time history of waves (1990–1999). Potential annual impacts of the Plan 1 borrow area on littoral transport are considered in terms of comparisons with the existing bathymetry. Although average annual littoral transport quantities are given, emphasis is on differences in the estimated littoral transport induced by the borrow area. All simulations were performed with the programs discussed in Chapter 3. Implications for beach erosion and accretion are discussed in Chapter 6.

### Existing bathymetry

Potential longshore transport rates for the existing bathymetry case are shown in Figure 19. Rates are given in units of cubic yards per year (cu yd/yr) for the 10-year average at each of the 236 monitoring stations. Simulation results are shown for transport to the south, north, net transport (sum of magnitudes for south and north transport rates, since north is negative), and gross (sum of absolute values of south and north transport rates). The color-coordinated vertical lines are the standard error bars for each curve, indicative of plus or minus one standard deviation of annual estimates about the 10-year average lines.

Southerly transport is relatively constant along the study coast, averaging about 97,000 cu yd/yr for all stations. Northerly transport decreases from a maximum of 399,000 cu yd/yr in the south (Station 12) to 143,000 cu yd/yr in the north (Station 232), with an average of 288,000 cu yd/yr. Net transport decreases from 315,000 cu yd/yr at Station 12 in the south to a minimum of 18,000 cu yd/yr at the northern Station 236 near the Chesapeake Bay entrance. The average net transport rate is 191,000 cu yd/yr to the north for all monitoring stations. It decreases with distance north after about Station 85, with another break in slope around Station 170. Gross transport rate decreases more or less continuously south to north along the study coast from a maximum of 484,000 cu yd/yr at Station 12 to a low of 253,000 cu yd/yr at Station 233. The average gross transport rate is 385,000 cu yd/yr for all monitoring stations. Table 5 lists statistics for the existing bathymetry case for south, north, net, and gross longshore transport rates.

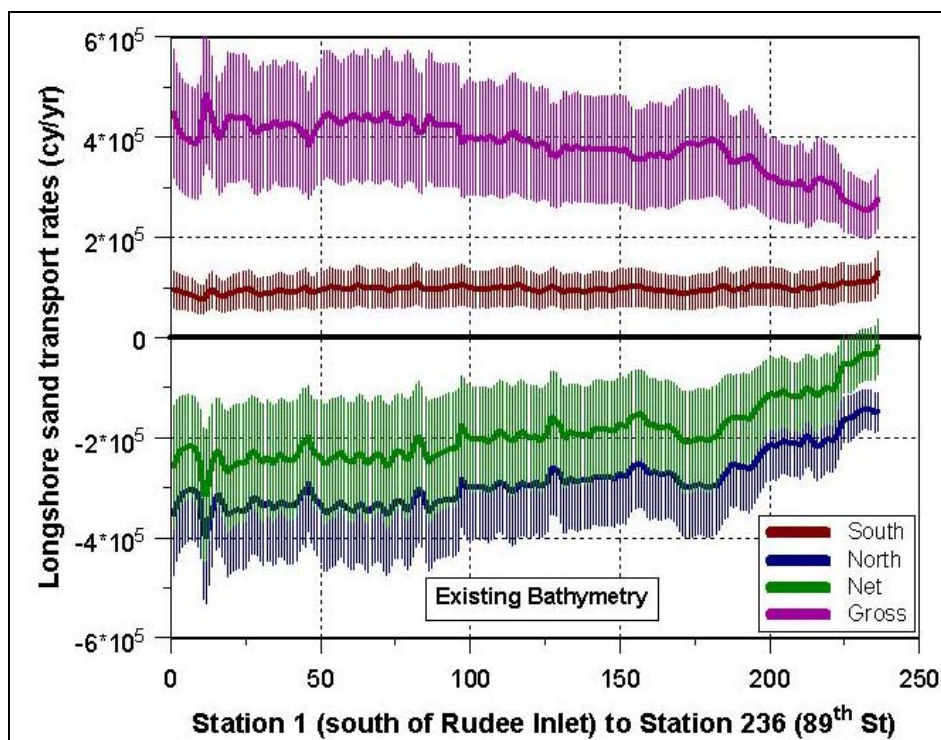


Figure 19. 10-year average annual longshore transport rates, existing bathymetry.

Table 5. Annual longshore transport statistics, existing bathymetry, 1990–1999, 1,000 cu yd/yr.

	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
<b>South</b>												
Min	29	63	81	95	124	63	61	101	48	86	75	28
Max	50	113	158	166	192	111	112	160	83	144	129	43
Ave	40	81	118	120	161	76	82	124	58	110	97	36
Std	3	6	11	8	9	6	6	7	4	7	7	2
<b>North</b>												
Min	-271	-218	-465	-385	-429	-511	-485	-202	-432	-604	-399	38
Max	-116	-72	-157	-140	-154	-163	-184	-89	-163	-191	-143	133
Ave	-202	-142	-318	-280	-318	-357	-355	-147	-319	-438	-288	96
Std	30	28	61	50	58	73	61	21	56	88	52	21
<b>Net</b>												
Min	-238	-146	-372	-284	-304	-441	-416	-89	-379	-518	-315	51
Max	-72	36	-6	25	36	-58	-77	65	-85	-48	-18	132
Ave	-161	-61	-200	-160	-157	-281	-273	-23	-261	-328	-191	99
Std	32	32	69	55	61	78	66	25	59	92	57	18
<b>Gross</b>												
Min	160	167	291	280	320	258	279	225	234	312	253	56
Max	303	289	559	493	567	580	553	315	486	696	484	139
Ave	242	222	437	400	479	433	437	271	377	548	385	108
Std	28	24	55	45	56	69	57	19	53	85	49	19

Minimum, maximum, average, and standard deviations are included for each year, the 10-year average and standard deviation. The standard deviations show the natural variability from year to year and for the 10-year averages.

### **Comparisons to previous studies with existing bathymetry**

The overall study objective is to quantify the impact, if any, of planned offshore borrow activities on potential longshore transport at Virginia Beach. Since the impact is expected to be small or insignificant, this study is not intended to develop a comprehensive sediment budget for the study area. For example, Rudee Inlet interrupts longshore transport and sediment is routinely bypassed to the beach north of the inlet. This interruption is not represented in the study results. However, historical data on the volume of sand needed to nourish Virginia Beach, including Rudee Inlet bypassing activities, gives a useful comparison to present study results. CENAO provided annual nourishment volumes for the 10-year study period, 1990 to 1999. The historical field data are compared to annual average longshore transport values for all model monitoring stations (Figure 20). The data fall between model gross and net transport volumes for most years and more nearly match gross than net transport. Although the data do not allow for a definitive comparison, the general level of agreement helps to validate model results.

In their analysis of sediment processes along the outer banks of North Carolina, Inman and Dolan (1989) discuss the presence of a longshore transport nodal point near False Cape, VA, the vicinity of the VA/NC border, with net transport toward the north along beaches north of the node and toward the south along beaches further south. Citing earlier studies, they estimate the net transport rate in the vicinity of Rudee Inlet as 209,300 cu yd/yr (160,000 cu m/yr). Estimates of annual net and gross longshore transport rates are also given for the stretch of coast between Cape Henry and Cape Hatteras, NC. Although the estimates are very coarse spatially and are based on early WIS hindcasts for the years 1956–75, they are reasonably consistent with present study results.

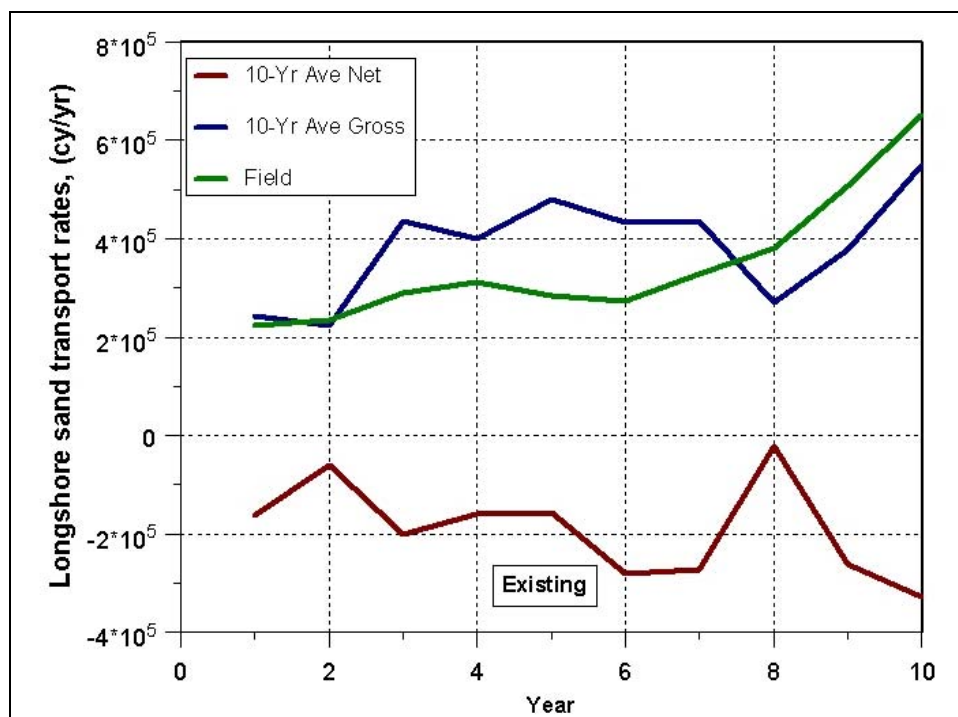


Figure 20. Comparison of historical resort beach sand nourishment with predicted average net and gross transport rates.

More recent numerical model studies were performed to evaluate the impact of planned borrow activities at Sandbridge Shoals, VA, which lies between Rudee Inlet and False Cape (Kelley and Ramsey 2001; Kelley et al. 2001). These studies used numerical model technology similar to the present study but with only eleven representative incident wave conditions. Potential longshore transport estimates were generated along a stretch of coast that encompassed Rudee Inlet and approximately the southern one-third of the present study area. From this study, smoothed transport rates around and north of Rudee Inlet are 200,000 cu m/yr southward, 320,000 cu m/yr northward, 120,000 cu m/yr net, and 680,100 cu yd/yr (520,000 cu m/yr) gross. Northward rates are reasonably comparable to the present study results. Southward rates are higher than the present study results. The discrepancy in southward transport rates may be attributed to the proximity of numerical grid northern boundaries in the Sandbridge Shoals studies. Southward longshore transport predictions along coasts near the northern grid boundaries may lose accuracy, because waves coming from the north and northwest directions are not fully accommodated in the grid.

In conjunction with the present study, available information about longshore transport rates was discussed with Professor David Basco, Old Dominion University, Norfolk, VA. Professor Basco confirmed that a net transport rate of around 200,000 cu yd/yr northward in the vicinity of Rudee Inlet is generally accepted, which is consistent with the present study results. He also indicated that there is considerable historical data that could be addressed if more detailed studies are needed in the future.

### **Plan 1 borrow area bathymetry**

Figure 21 is a plot of the 10-year average longshore transport rates for Plan 1 with the borrow pit. The south, north, net, and gross longshore transport rates are shown, similar to Figure 19 for the existing bathymetry case. The statistical error bars are again shown on each curve. Table 6 summarizes transport rate statistics for the Plan 1 bathymetry, analogous to Table 5 for the existing bathymetry case.

In general, longshore transport rates for south, north, net, and gross are similar for the Plan 1 bathymetry cases. Southerly transport remains relatively constant along the study coast, averaging the same as the existing case (97,000 cu yd/yr) for all stations. Northerly transport decreases from a maximum of 397,000 cu yd/yr at Station 12 to 120,000 cu yd/yr in the north at Station 232, with an average of 282,000 cu yd/yr. Net transport decreases from 312,000 cu yd/yr at Station 12 in the south to a minimum of 4,000 cu yd/yr at the northern Station 236. The average net transport rate is 185,000 cu yd/yr to the north, a slight decrease from the existing case. Gross transport rate decreases more or less continuously south to north along the study coast from a maximum of 483,000 cu yd/yr at Station 12 to a low of 230,000 cu yd/yr at Station 232. The average gross transport rate is 379,000 cu yd/yr for all monitoring stations, again down slightly from the existing case.

### **Changes in longshore transport between cases**

Comparing Figures 19 and 21 for the existing and Plan 1 cases, it appears that longshore transport rates show little change for the transport in the southerly direction. There are some changes for the north, net, and gross transport rates, however, especially farther to the north. To highlight this fact, the two 10-year average net curves for existing and Plan 1 cases (from Figures 19 and 21, respectively) are overlain in Figure 22.



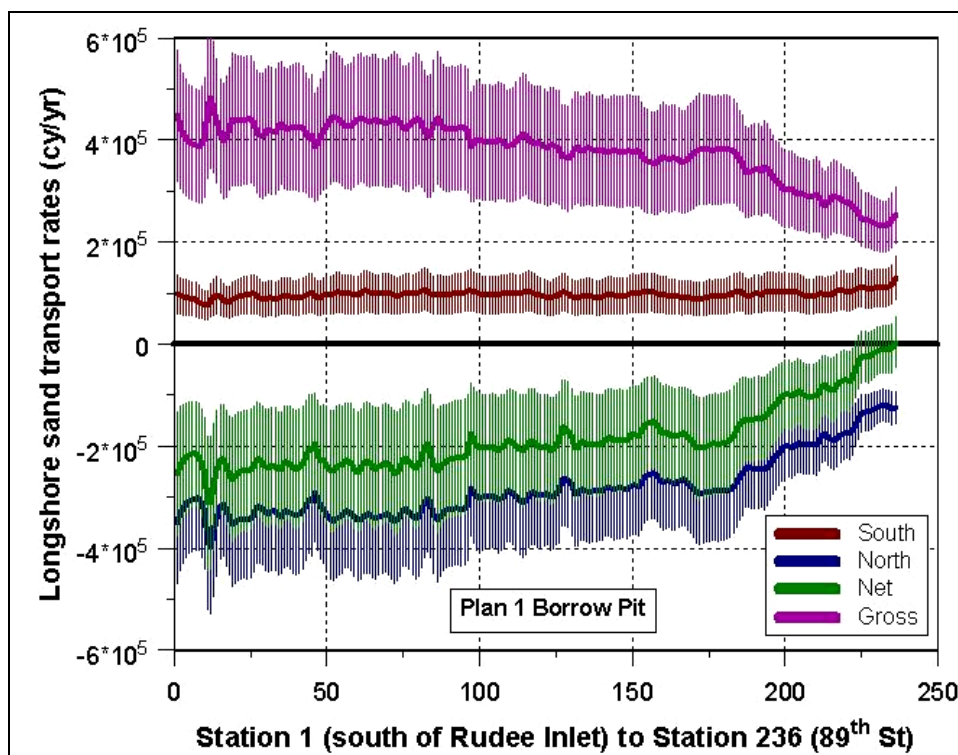


Figure 21. 10-year average annual longshore transport rates, Plan 1 borrow area.

Table 6. Annual longshore transport statistics, Plan 1 bathymetry, 1990–1999, 1,000 cu yd/yr

	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
<b>South</b>												
Min	29	63	83	96	124	63	61	101	48	86	76	28
Max	50	112	156	167	192	112	113	161	84	145	129	43
Ave	40	81	119	120	161	76	82	124	58	110	97	36
Std	3	6	10	8	9	6	6	7	4	7	6	2
<b>North</b>												
Min	-269	-215	-461	-382	-428	-508	-481	-200	-430	-603	-397	31
Max	-99	-64	-133	-117	-129	-129	-154	-77	-139	-157	-120	132
Ave	-199	-139	-311	-275	-312	-349	-349	-145	-314	-428	-282	94
Std	35	29	67	57	66	84	70	24	63	100	59	24
<b>Net</b>												
Min	-237	-143	-367	-282	-302	-439	-412	-88	-377	-516	-312	46
Max	-54	44	14	47	58	-24	-45	78	-59	-16	4	132
Ave	-158	-58	-192	-155	-150	-273	-267	-21	-255	-319	-185	97
Std	37	33	74	62	69	89	74	28	66	103	63	21
<b>Gross</b>												
Min	143	159	269	257	294	224	250	213	210	280	230	50
Max	302	288	557	491	567	578	551	315	484	695	483	139
Ave	239	219	430	395	473	425	431	269	372	538	379	106
Std	34	26	62	52	64	80	67	22	60	97	56	21

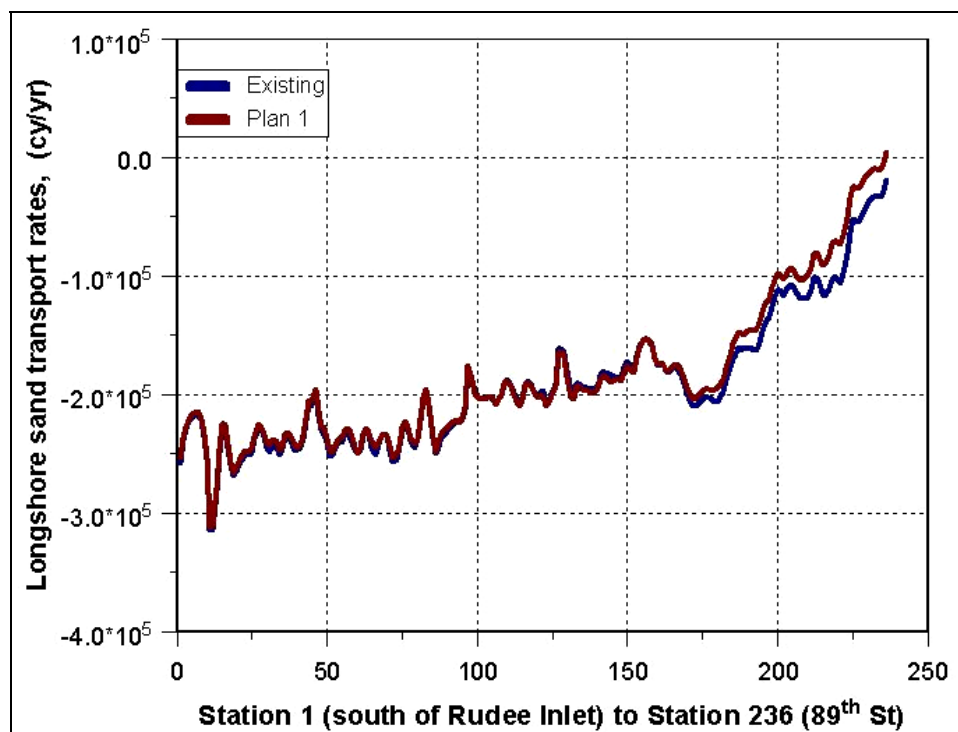


Figure 22. Comparison of existing and Plan 1 10-year average net transport rates.

The small differences in net transport between the existing and Plan 1 cases are highlighted. The transport rates begin to diverge around Station 174, decreasing to the north for the Plan 1 bathymetry case, relative to the existing case. If a control volume is drawn around Stations 170 to 236 on Figure 22, for both existing and Plan 1 scenarios, accumulation occurs within the control volume since more sediment is entering in the south than leaving the control volume at the northern perimeter. Moreover, since the net transport is smaller for Plan 1, especially at the northern perimeter, it will accumulate more sediment than the existing case. Thus, the main impact of the borrow area is to decrease the amount of net northward longshore transport up to 32,000 cu yd/yr between Stations 170 and 236. This will tend to promote sand retention along this section of the shoreline.

This change in net transport is again demonstrated in Figure 23. It shows the changes between Plan 1 and existing cases (i.e., Change = Plan 1 – Existing) for the south, north, net, and gross transport rates (analogous to Figures 19 and 21). The statistical error bars (i.e., standard errors of the estimates) are again shown for reference. As noted above, the changes in southward transport are insignificant. Northward changes are not visible

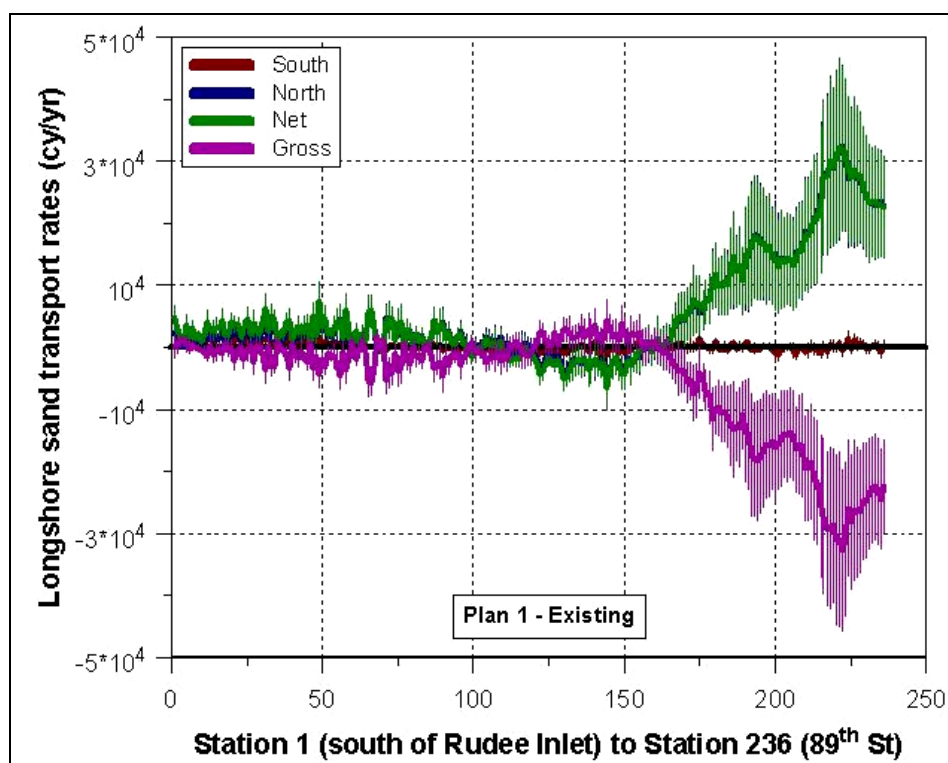


Figure 23. Impact of borrow area on average annual longshore transport rates, Plan 1 – existing bathymetry.

since they are overlain by the net changes. Changes for north, net, and gross transport from approximately Station 160 to 236 show a clear impact of borrow activities. Note that the net transport is the sum of the southerly (positive) transport and the northerly (negative) transport. A positive net transport change (i.e., P1 – Ex) then implies that Plan 1 reduces northerly and net transport relative to the existing bathymetry. Net transport rate changes decrease (i.e., positive differences) to the north up to approximately 32,000 cu yd/yr near Station 220 and then decrease to about 23,000 cu yd/yr at Station 236. Changes in net transport rates are positive along nearly the entire affected coast, indicating a pit-induced reduction of northerly transport. This reduction in transport rate implies more accumulation of sediment along the northern part of the study coast due to the borrow area. Table 7 again summarizes the statistics for the changes between Plan 1 and existing cases for south, north, net, and gross transport rates.

The curves in Figure 23 are for the 10-year average transport rates. The variation in the net transport rate changes for each of the years in the 10-year time period is shown in Figure 24. The minimum and maximum range of change in net transport rates is between 10,000 cu yd/yr at

Table 7. Annual longshore transport statistics, changes between Plan 1 and existing cases, 1990-1999, 1,000 cu yd/yr

Desc.	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
<b>South</b>												
Min	-1	-2	-5	-2	-3	-1	-1	-2	-1	-3	-1	0
Max	1	2	5	3	5	2	3	3	1	4	2	1
Ave	0	0	0	0	0	0	0	0	0	0	0	1
Std	0	1	2	1	1	1	1	1	0	1	1	0
<b>North</b>												
Min	-4	-3	-4	-5	-7	-11	-7	-2	-4	-11	-5	0
Max	24	11	31	32	36	51	42	15	34	54	32	14
Ave	3	3	7	5	6	8	6	2	6	10	6	3
Std	7	3	8	9	10	14	12	4	9	14	9	3
<b>Net</b>												
Min	-4	-3	-6	-6	-9	-11	-8	-4	-5	-12	-7	0
Max	24	11	29	32	37	50	42	16	33	56	32	14
Ave	3	3	7	5	7	8	6	2	6	10	6	4
Std	6	3	8	9	10	14	12	4	9	15	9	3
<b>Gross</b>												
Min	-25	-12	-34	-32	-35	-53	-42	-15	-34	-53	-33	0
Max	5	2	4	4	5	10	7	2	4	9	4	14
Ave	-3	-3	-7	-5	-6	-8	-6	-2	-6	-9	-5	3
Std	7	3	9	8	10	15	12	4	9	14	9	3

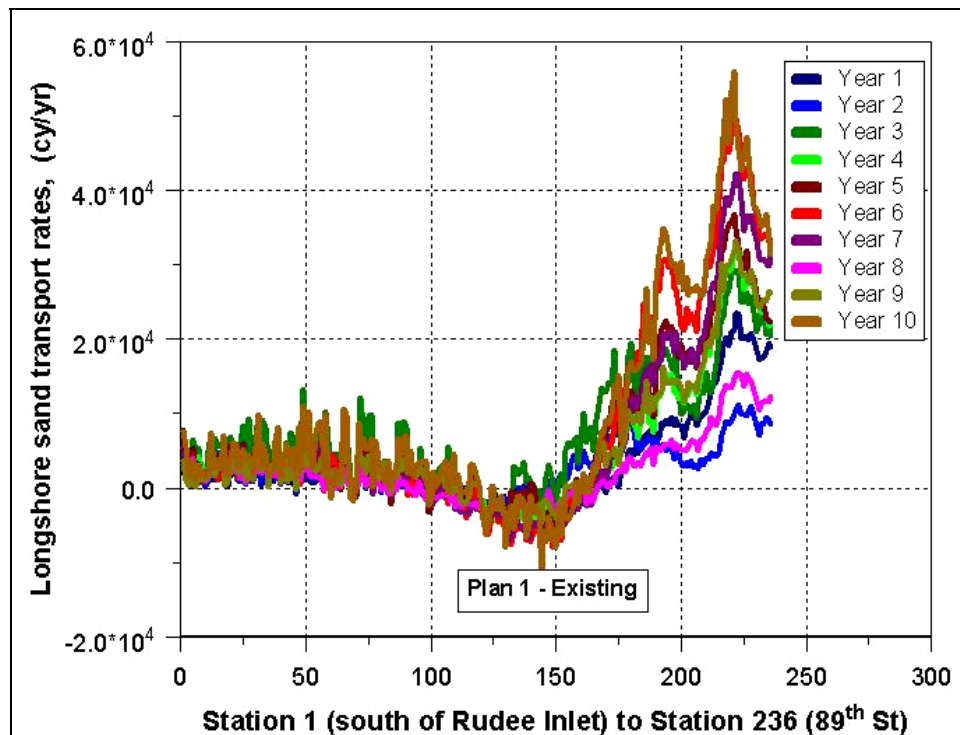


Figure 24. Impact of borrow area on annual net longshore transport rates, Plan 1 - existing bathymetry.

Station 145 to 56,000 cu yd/yr to the north at the peak near Station 220. These curves illustrate that the impact of Plan 1 on the net longshore transport rate can vary considerably from year to year. They also show how the gradient (i.e., the rate of change of the transport rate or slope of the transport rate) varies from year to year. Drawing a control volume around stations 150 to 200 and looking at the gradient between stations illustrates this point. A steeper gradient for the change in net transport implies decreasing transport to the north between southerly and northerly stations for Plan 1 relative to the existing case. Thus, sediment may be better retained in the north part of the study area for Plan 1 during years when the gradient of net transport changes is steep.

Average annual longshore transport rate curves from 1990 to 1999 are contained in Appendix B for south, north, net, and gross transports for the existing bathymetry case. Plots for Plan 1 are contained in Appendix C. Appendix D contains the plots for the change condition, Plan 1 – Existing bathymetry. Because some of the change values are relatively small, they are shown to two decimal place accuracy while still being divided by 1,000 as in the other appendices.

Although the Plan 1 borrow excavation clearly appears to impact potential longshore transport in the northern part of the study area, considering whether this impact is significant is important. Consideration of annual variations that naturally occur owing to year-to-year wave climate variations gives a useful perspective. Figure 25 shows the standard deviation  $\sigma$  of the annual net transport for the existing bathymetry over the 10-year period along with the average net transport difference curve repeated from Figure 23. For the coastline most impacted by borrow activities, around Station 220, natural year-to-year variations in existing annual net transport rate, as represented by  $\sigma$ , are 3–4 times as large as differences induced by the proposed borrow activities.

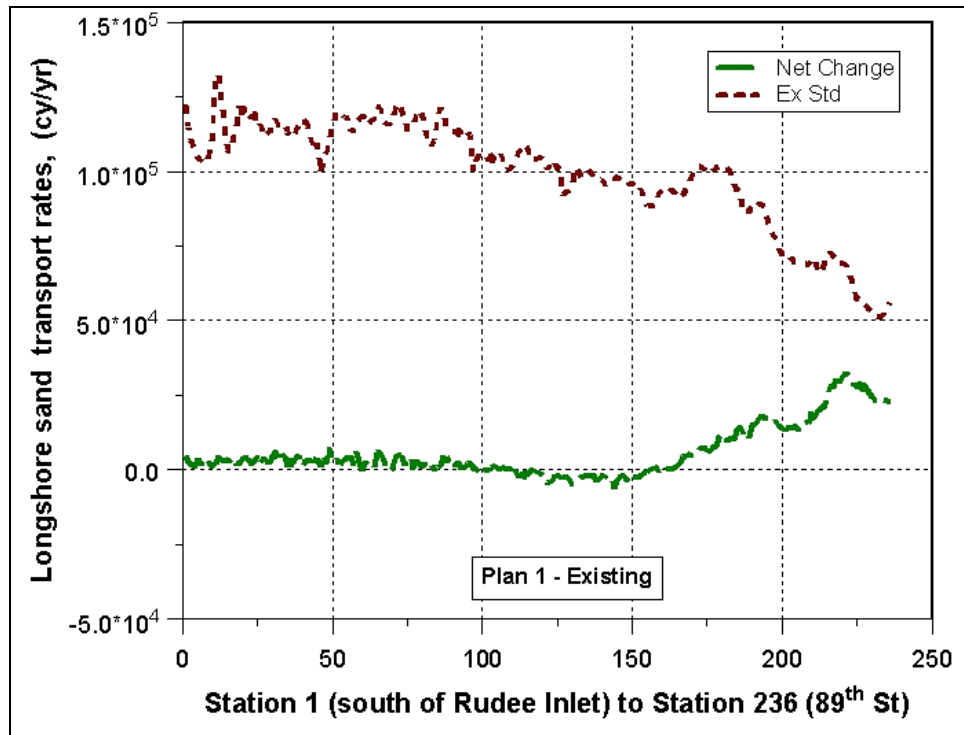


Figure 25. Change in net transport between Plan 1 and existing with standard deviation for existing bathymetry.

## 6 Summary and Conclusions

1. The U.S. Army Corps of Engineers, Norfolk District (CENAO), is preparing an Environmental Assessment for the use of sand sources off the coast of Cape Henry for future maintenance of the Virginia Beach, VA, shoreline. The primary purpose of the project is to maintain a buffer for hurricane protection for structures landward of the existing beach.
2. The Cape Henry borrow area is being considered as a sand source. It is a roughly triangular-shaped area, located adjacent to Virginia Beach, VA, and the Atlantic Ocean Navigation Channel. The plan borrow scenario involves removing approximately 34.2 M cu yd of material from the borrow area over a period of 50 years. Plan borrow activities will deepen the existing bottom in the seaward portion of the Cape Henry borrow area by 4.3 m (14 ft) over an area of approximately 66M sq ft.
3. The study objective is to provide wave climate and potential longshore transport information and analysis for two bathymetric cases: existing bathymetry and Plan 1 with planned excavation from the Cape Henry borrow area. These two cases will bracket the range of expected conditions over the next 50 years and enable assessment of potential project impacts on littoral transport patterns along adjacent beaches. Thus, the overall objective is to quantify the impact, if any, of planned offshore borrow activity on potential longshore transport at Virginia Beach. Since the impact was expected to be small or insignificant, this study is not intended to develop a comprehensive sediment budget for the study area. For example, Rudee Inlet interrupts longshore transport and sediment is routinely bypassed to the beach north of the inlet. This interruption is not represented in the study results.
4. Offshore wind wave and swell climate was represented by Wave Information Studies (WIS) hindcast information covering the 10-year time period 1990–99. WIS Station 197 (13 miles from the Virginia Beach coast in nominal water depth of 56 ft MLLW) was selected for comparisons since it is directly offshore from the beaches and more representative for the study area. The WIS wave information compared favorably to data from three gage sites in the general location of the study area. The WIS information is more complete than the gage records.
5. The 10-year wave data were summarized using the program NEMOS (Nearshore Evolution Modeling System), a part of the CEDAS (Coastal Engineering Design and Analysis System). The most common direction

- band, with 12.2 percent of the cases, is between 72 to 82 deg, with a mean of 76.3 deg, approximately perpendicular to shore. The most commonly occurring wave period band, with 39.9 percent of the cases, is 3 to 5 sec. The overall mean peak wave period is 6.7 sec. The standard deviation of wave period is 3 sec. Seventy-two percent of the cases fall in the 0 to 1 m band. Overall mean significant height is 0.9 m, with a standard deviation of 0.6 m. The highest significant wave height is 5.8 m, with corresponding peak period of 12.3 sec and direction of 88 deg azimuth.
6. Wave transformation from deep to intermediate water depths was performed with the finite difference STWAVE (Spectral Wave) model. It includes the coastal processes of refraction, shoaling, and depth-limited wave breaking. The STWAVE model is contained in the SMS (Surface Water Modeling System).
  7. The model domain extended north into the mouth of Chesapeake Bay and south to near False Cape (Virginia and North Carolina border), beyond expected plan impacts. The STWAVE model was configured to estimate wave transformation between WIS Station 197 and the Virginia Beach coast. The model domain extends 15 km (8 nm) in the offshore direction and 47 km (25 nm) alongshore.
  8. One water level was used for all simulations, corresponding to the MLLW. The Rudee Inlet Station, which is representative of the study area, shows a difference between MSL and MLLW of only 0.56 m (1.8 ft). MLLW was chosen for simulations to ensure that possible impacts of the offshore borrow area would be evident. The overall effect of the borrow pit on longshore transport may be slightly amplified in the study owing to the choice of water level.
  9. Digital bathymetry, with 3-arc-second Coastal Relief Model database resolution, was obtained from the National Oceanic and Atmospheric Administration (NOAA) for the study area. A finite difference grid for STWAVE was constructed over the model domain using SMS. Resolution is 50 m (164 ft), which has sufficed in previous, similar studies and is reasonable relative to the 3-sec (92.5-m or 304-ft) resolution of the NGDC bathymetric database. The grid was built in the State Plane coordinate system.
  10. Based on the hindcast wave climate, a representative range of five significant wave heights ( $H_s = 1, 2, 3, 4, \text{ and } 5\text{ m}$ ), nine peak wave periods ( $T_p = 4, 6, 8, 10, 12, 14, 16, 18, \text{ and } 20\text{ sec}$ ), and eleven peak wave directions ( $\bar{\theta} = 27, 37, 47, 57, 67, 77, 87, 97, 107, 117, \text{ and } 127\text{ deg}$ ) were included in the STWAVE modeling. A total of 495 wave conditions (5 heights  $\times$  9 periods  $\times$  11 directions) were modeled as directional wave



- spectra at the offshore boundary. The directional spectrum consists of a TMA frequency spectrum and a  $\text{Cos}^n$  spreading function. Spectral wave parameters were selected for each wave based on wave period. One water level was used for all simulations, corresponding to the MLLW at the offshore boundary of 16 m (52 ft).
11. For estimating the impact of these waves on longshore sand transport rates, 236 nearshore monitoring stations were located along the 6 m (20 ft) contour, where bottom contours were reasonably parallel to the shoreline. The selection of the 6-m contour is not exact, so including the larger 5-m wave height cases even though they might have experienced some breaking offshore from this location was felt to be satisfactory. Station 1 was located south of Rudee Inlet and Station 236 was positioned near 89th Street. The distance between stations is 50 m (164 ft), the same as the STWAVE grid spacing.
  12. The computer program VaBeach\_Timehist was used to transform the STWAVE wave data and create a 10-year time history at each nearshore monitoring station. This transformed wave data at each monitoring station was then input to the computer program VaBeach\_Qcalc to (a) create a 10-year time history of near-breaking wave parameters, (b) transform the near-breaking waves to a point at which breaking begins, and (c) compute the potential longshore transport rate from that breaking wave height and angle.
  13. In this report, six of the 495 incident wave conditions were chosen to illustrate wave transformation patterns. These six events include two wave periods ( $T_p = 8$  and 12 sec) and three wave directions ( $\bar{\theta} = 37, 77,$  and 117 deg) for the average significant wave height of 1 m. The two wave periods are representative of sea and swell waves during storms. The wave directions bracket waves from the northeast, southeast, and normal to shore.
  14. On a regional scale for these 6 events, the changes in wave heights between the Plan 1 and existing bathymetry are relatively small. The changes range from  $-0.16$  m (higher existing wave heights) to  $0.12$  m (higher Plan 1 wave heights). The largest changes occur for waves perpendicular to shore ( $\bar{\theta} = 77$  deg) or from the southeast ( $\bar{\theta} = 117$  deg) and for the longer wave period ( $T_p = 12$  sec). Plan 1 wave heights are generally higher than existing bathymetry values on the northern and southern ends of the borrow area, but lower in the lee to the west of the borrow area.
  15. A better predictor of potential littoral transport differences is to examine the changes in wave height and direction at the 236 monitoring stations. Wave heights range from approximately 0.8 to 1.2 m for the six events.

- In general for the existing bathymetry, Event 1 ( $T_p = 8$  sec,  $\bar{\theta} = 37$  deg) has the lowest wave heights and Event 5 ( $T_p = 12$  sec,  $\bar{\theta} = 77$  deg) the highest. Changes in wave height range from approximately  $-0.12$  to  $0.03$  m (positive values indicate higher wave heights for the Plan 1 cases). The impact of the borrow area on the northern stations is stronger for the southeast waves. In general, wave height changes due to Plan 1 are relatively small, and in most cases are reduced. Wave direction does not appear to be significantly changed by either wave period for the existing bathymetry. Differences in wave direction between existing and Plan 1 are insignificant. In general, wave direction decreases toward the north, becoming more southerly.
16. Contributions during each year in the time history of wave conditions are combined to give annual north and south potential longshore transport rates. Net potential longshore transport rates are determined as the sum in magnitude between north and south rates, since northward transport is negative. Gross potential longshore transport rates are the combined absolute magnitudes of north and south transport rates. Annual longshore transport rates from all 10 years of wave information can be combined to give average annual rates and standard deviations, which provide a helpful measure of expected variability between years.
  17. For existing bathymetry transport rates averaged over 10 years, southerly transport is relatively constant, averaging about 97,000 cu yd/yr for all stations. Northerly transport decreases from a maximum of 399,000 cu yd/yr in the south to 143,000 cu yd/yr in the north, with an average of 288,000 cu yd/yr. Net transport to the north decreases from 315,000 cu yd/yr in the south to a minimum of 18,000 cu yd/yr in the north, near the Chesapeake Bay entrance. The average net transport rate is 191,000 cu yd/yr to the north for all monitoring stations. It decreases with distance north after about Station 85. Gross transport rate decreases more or less continuously south to north along the study coast from a maximum of 484,000 cu yd/yr to a low of 253,000 cu yd/yr. The average gross transport rate is 385,000 cu yd/yr for all monitoring stations.
  18. The existing bathymetry case was compared to available information about longshore transport rates along the study coast, which helped validate the model estimates of annual transport rates.
  19. In general, 10-year average longshore transport rates for Plan 1 are similar to the existing bathymetry. Southerly transport stays the same and northerly transport decreases from a maximum of 397,000 cu yd/yr in the south to 120,000 cu yd/yr in the north, with an average of 282,000 cu yd/yr. Net transport decreases from 312,000 cu yd/yr in the

- south to a minimum of 4,000 cu yd/yr in the north. The average net transport rate is 185,000 cu yd/yr to the north, a slight decrease from the existing case. Gross transport rate decreases more or less continuously south to north along the study coast from a maximum of 483,000 cu yd/yr to a low of 230,000 cu yd/yr in the north. The average gross transport rate is 379,000 cu yd/yr for all monitoring stations, again down slightly from the existing case. These differences are certainly within the uncertainty of transport predictions.
20. Changes between Plan 1 and existing longshore transport rates were investigated. There is little change in the southward transport along the entire length of shoreline within this study. Changes are more pronounced, however, farther to the north, especially for the net and gross transport rates. The transport rates begin to diverge around Station 174, decreasing to the north for the Plan 1 bathymetry case. Thus, the main impact of the borrow area is to decrease the amount of net northward longshore transport north of Station 174 by up to 32,000 cu yd/yr. Changes in transport rates are positive along nearly the entire affected coast, indicating a pit-induced reduction of northerly transport. This reduction in transport rate implies more accumulation of sediment along the northern part of the study coast owing to the borrow area.
  21. Analyses and conclusions to this point were based on the changes in the 10-year average transport rates. Examining the individual years shows that the minimum and maximum range in change in net transport rates are between 10,000 cu yd/yr to 56,000 cu yd/yr to the north at the peak near Station 220. This gives a wider range on the potential longshore transport rates resulting from the Plan 1 borrow excavation. The gradients of the transport rates (or rate of change in transport rates) are variable from year to year. The gradient is important in the prediction of where the sediment goes along the shoreline and how the shoreline might change with time. The purpose of this study was focused on differences between existing and Plan 1 transport and how significant these differences are relative to the borrow site impact.
  22. Although the Plan 1 borrow excavation clearly appears to impact potential longshore transport in the northern part of the study area, considering whether this impact is significant is important. Consideration of annual variations that naturally occur resulting from year-to-year wave climate variations gives a useful perspective. For the coastline most impacted by borrow activities, around Station 220, natural year-to-year variations in existing annual net transport rate are 3–4 times as large as differences induced by the proposed borrow activities.

23. Partial excavation of the borrow area could cause local “hot spots” within the project area, especially near the end points. Although it is not possible to predict the formation or likelihood of these hot spots at this time, the possibility that they might occur over the life of the project should be noted.
24. Finally, these projections are based on a change over a 50-year duration. In this time, the probability that the beach and nearshore bathymetry will change and adapt incrementally to the changes that will be occurring over a 50-year period should be expected. The study predictions do not assume any infilling of the borrow area during this time. This is probably a conservative approach.

## References

- Bodge, K. R. 1989. A literature review of the distribution of longshore sediment transport across the surf zone. *Journal of Coastal Research* 5(2):307–328.
- Boon, J. D. 1997. Wave climate and wave monitoring in lower Chesapeake Bay. Proceedings, *3rd International Symposium on Ocean Wave Measurement and Analysis*, ASCE, 2:1076–1087. Virginia Beach, VA.
- Brooks, R. M., and W. A. Brandon. 1995. *Hindcast wave information for the U.S. Atlantic Coast: Update 1976–1993 with hurricanes*. WIS Report 33. Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station.
- Cialone, M. A., and E. F. Thompson. 2000. *Wave climate and littoral sediment transport potential, Long Beach Island, New Jersey*. Technical Report ERDC/CHL TR-00-21. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
- Corson, W. D., D. T. Resio, R. M. Brooks, B. A. Ebersole, R. E. Jensen, D. S. Ragsdale, and B. A. Tracy. 1982. *Atlantic coast hindcast, Phase II wave information*. WIS Report 6. Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station.
- Farnsworth, K. L., and J. D. Boon. 1997. Response modes of the Chesapeake Bay wave field. *Ocean Wave Measurement and Analysis*, ASCE, 1469–1477.
- Goldsmith, V., S. C. Sturm, and G. R. Thomas. 1977. *Beach erosion and accretion at Virginia Beach, Virginia, and vicinity*. Miscellaneous Report MR-77-12. Fort Belvoir, VA: U.S. Army Engineer Coastal Engineering Research Center.
- Inman, D. L., and R. Dolan, R. 1989. The outer banks of North Carolina: Budget of sediment and inlet dynamics along a migrating barrier system. *Journal of Coastal Research* 5(2):193–237.
- Jensen, R. E. 1983. *Methodology for the calculation of a shallow-water wave climate*. WIS Report 8. Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station.
- Kelley, S. W., and J. S. Ramsey. 2001. *Cumulative impacts from dredging at Sandbridge Shoals, Virginia*. Mashpee, MA: Applied Coastal Research and Engineering, Inc.
- Kelley, S. W., J. S. Ramsey, and M. R. Byrnes. 2001. *Numerical wave model analysis Sandbridge Shoal: Proposed Spring 2002 Sandbridge Beach, Virginia renourishment*. Prepared under MMS Contract Number 1435-01-99-CT-30993. Mashpee, MA: Applied Coastal Research and Engineering, Inc.
- NEMOS. 2000. Nearshore Evolution Modeling System, Version 1.01C. Vicksburg, MS: Veri-Tech, Inc.
- Smith, J. M., and S. J. Smith. 2002. *Grid nesting with STWAVE*. Coastal and Hydraulics Engineering Technical Note ERDC/CHL CHETN-I-66. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

- Smith, J. M., A. R. Sherlock, and D. T. Resio. 2001. *STWAVE: Steady-state spectral wave model, Report 1, User's manual for STWAVE Version 3.0*. Instruction Report CHL-99-1. Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station.
- SMS. 2000. *Surface-Water Modeling System*. Version 7.1. Provo, UT: Brigham Young University.
- Thompson, E. F., and M. B. Gravens (in preparation). *Wave climate and littoral sediment transport potential for Brunswick County beaches, North Carolina—Cape Fear to Long Beach*. Draft Technical Report. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
- Thompson, E. F., L. L. Lin, and D. L. Jones. 1999. *Wave climate and littoral sediment transport potential, Cape Fear River entrance and Smith Island to Ocean Isle Beach, North Carolina*. Technical Report CHL-99-18. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
- U.S. Army Corps of Engineers (USACE). 1992. *Coastal littoral transport*. Engineer Manual EM 1110-2-1502. Washington, DC: U.S. Army Corps of Engineers.

## Appendix A: STWAVE Input Wave Parameters

Table A1. STWAVE wave parameters.

Index	H, m	T, sec	$\gamma$	n
1	1.00	4	3.30	4
2		6	3.30	4
3		8	3.30	4
4		10	3.30	4
5		12	4.00	10
6		14	5.00	16
7		16	6.00	20
8		18	7.00	26
9		20	8.00	30
10	2.00	4	3.30	4
11		6	3.30	4
12		8	3.30	4
13		10	3.30	4
14		12	4.00	10
15		14	5.00	16
16		16	6.00	20
17		18	7.00	26
18		20	8.00	30
19	3.00	4	3.30	4
20		6	3.30	4
21		8	3.30	4
22		10	3.30	4
23		12	4.00	10
24		14	5.00	16
25		16	6.00	20
26		18	7.00	26
27		20	8.00	30
28	4.00	4	3.30	4
29		6	3.30	4
30		8	3.30	4
31		10	3.30	4
32		12	4.00	10
33		14	5.00	16
34		16	6.00	20
35		18	7.00	26
36		20	8.00	30
37	5.00	4	3.30	4
38		6	3.30	4
39		8	3.30	4
40		10	3.30	4
41		12	4.00	10
42		14	5.00	16
43		16	6.00	20
44		18	7.00	26
45		20	8.00	30

## **Appendix B: Average Annual Longshore Transport Rates for Existing Bathymetry<sup>1</sup>**

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<sup>1</sup> This appendix contains figures and tables for south, north, net, and gross longshore transport rates.



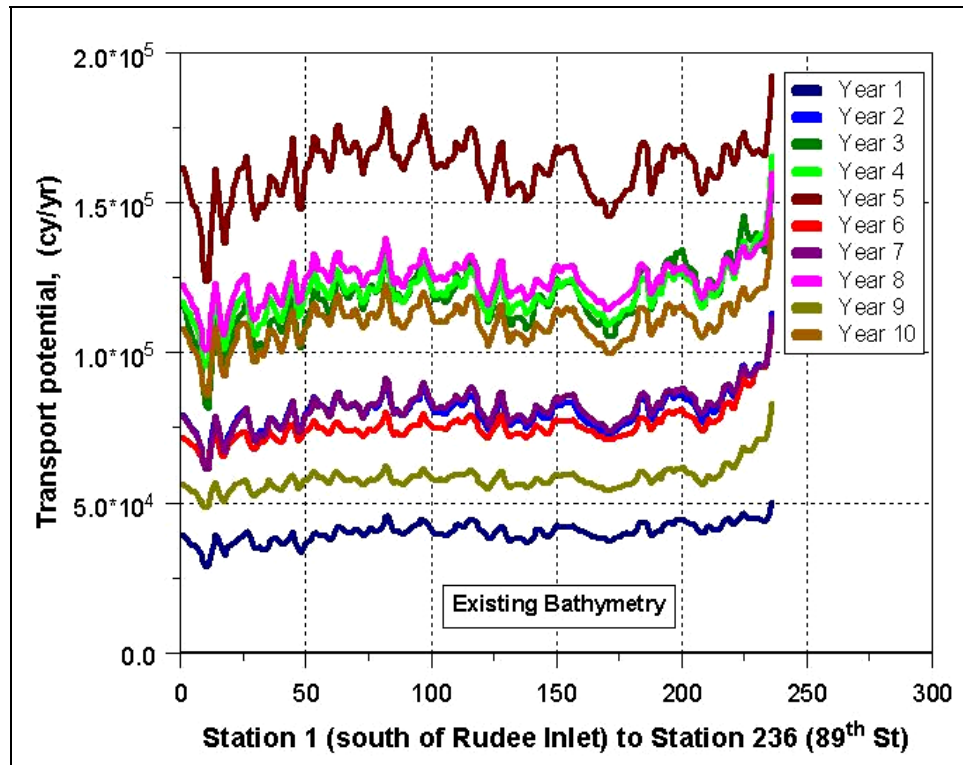


Figure B1. Average annual south longshore transport rates for monitoring stations, existing bathymetry.

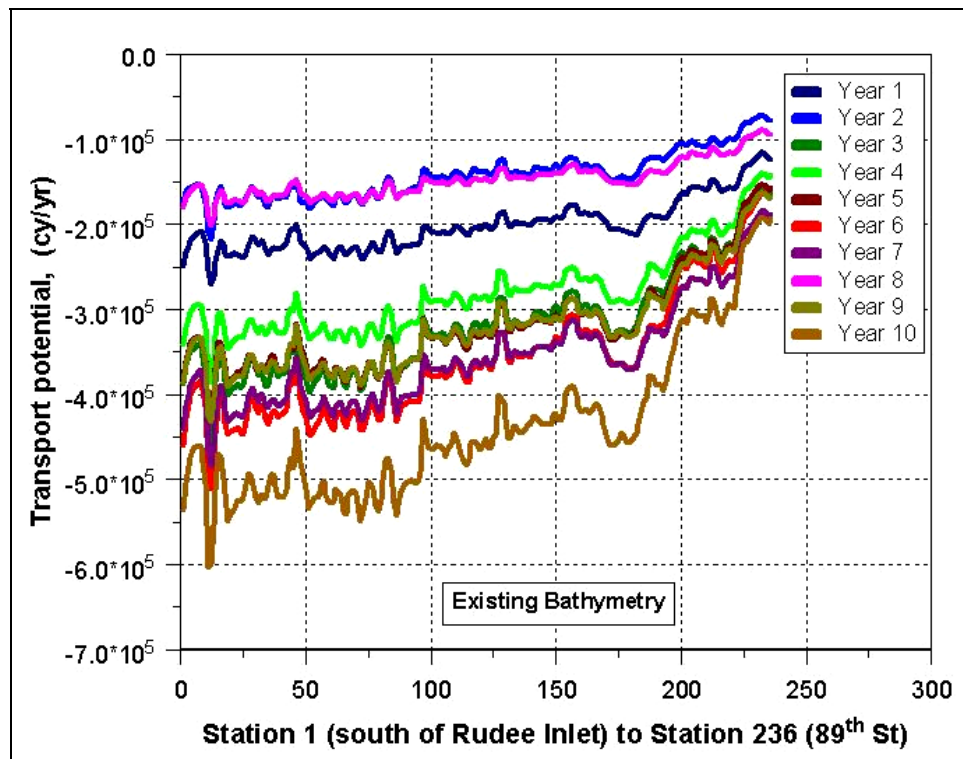


Figure B2. Average annual north longshore transport rates for monitoring stations, existing bathymetry.

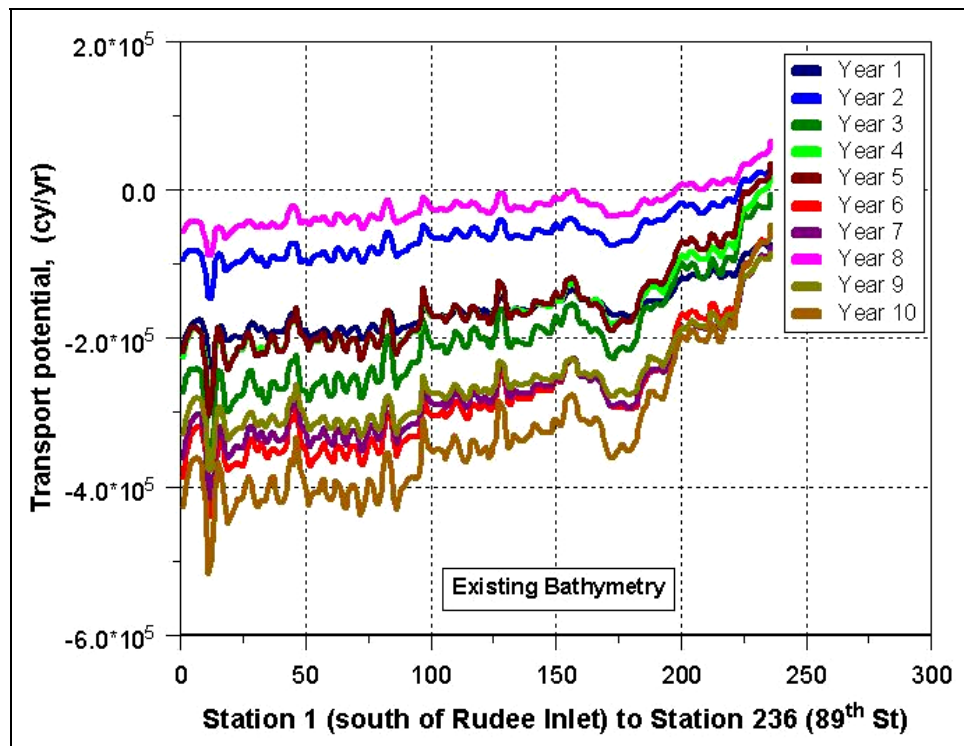


Figure B3. Average annual net longshore transport rates for monitoring stations, existing bathymetry

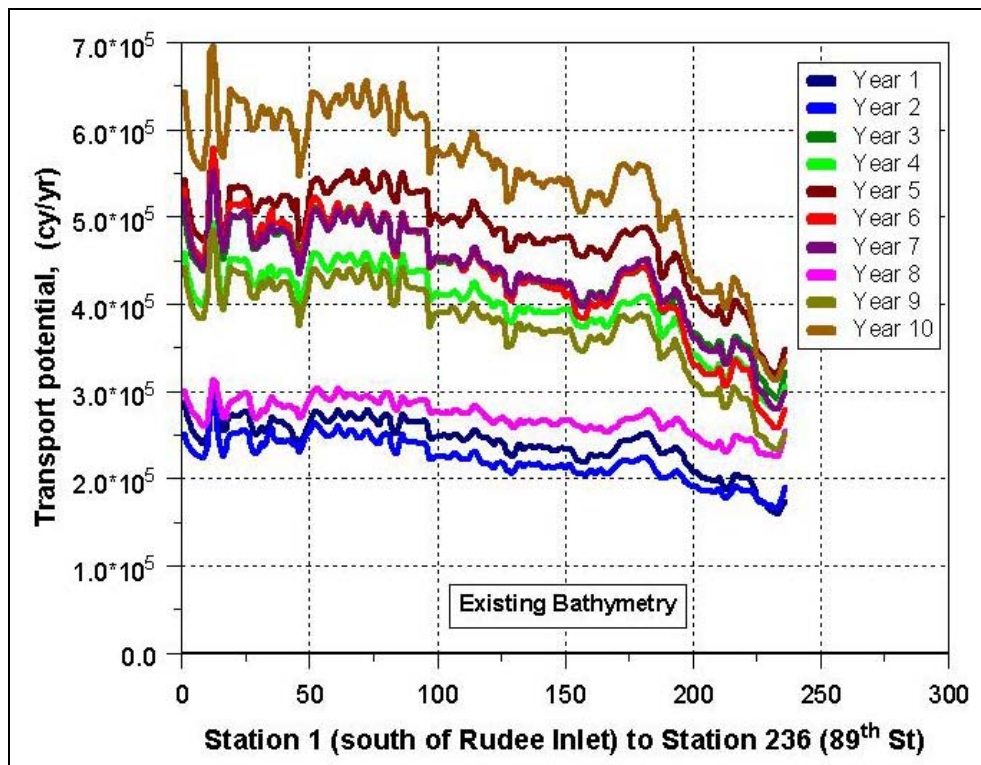


Figure B4. Average annual gross longshore transport rates for monitoring stations, existing bathymetry

Table B1. Southern longshore transport rates, existing bathymetry, 1990–1999, 1,000 cu yd/yr.

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
1	39	79	116	117	162	72	79	123	56	108	95	36
2	38	78	113	115	159	71	78	120	55	106	93	36
3	37	77	109	114	155	70	76	119	55	105	92	35
4	36	76	107	113	153	70	76	118	55	103	91	34
5	36	74	104	110	149	69	74	115	54	101	89	33
6	36	74	104	109	148	69	74	115	53	101	88	33
7	34	71	101	106	145	67	71	111	52	98	86	33
8	33	69	96	103	139	66	68	108	51	93	83	31
9	31	65	89	98	130	64	64	103	49	89	78	29
10	29	63	83	95	124	63	61	101	48	86	75	28
11	29	64	81	97	124	64	61	102	49	86	76	28
12	33	71	93	108	140	69	68	114	53	97	85	32
13	36	77	105	115	153	71	74	120	56	105	91	35
14	40	79	115	117	161	72	79	123	57	109	95	36
15	38	75	110	112	154	70	76	117	54	104	91	35
16	35	70	103	105	145	66	71	109	51	95	85	32
17	34	68	96	101	137	66	67	106	50	92	82	30
18	32	68	92	102	136	66	67	108	51	92	82	30
19	35	72	101	107	146	69	71	113	53	98	87	33
20	36	74	103	109	149	70	72	116	54	100	88	33
21	37	76	108	114	155	71	75	119	55	103	91	35
22	37	77	109	115	158	72	77	121	56	105	93	36
23	38	79	111	117	160	73	78	123	57	108	94	36
24	38	80	112	118	161	73	79	124	57	109	95	36
25	39	80	113	119	162	74	79	125	57	110	96	36
26	40	81	118	120	166	73	82	126	57	110	97	37
27	40	79	117	117	162	72	79	122	56	108	95	36
28	39	75	110	110	153	69	75	115	54	102	90	34
29	36	71	104	106	147	67	72	111	52	97	86	33
30	35	71	100	106	144	68	70	111	53	97	86	32
31	35	73	103	109	148	70	72	115	54	100	88	33
32	35	74	103	110	150	70	73	116	54	101	89	33
33	34	73	101	110	148	70	72	115	54	99	88	33
34	34	75	102	113	150	71	73	118	55	102	89	34
35	36	78	106	118	155	74	77	122	58	108	93	35
36	38	78	111	118	159	73	78	123	57	107	94	36
37	38	78	111	116	158	72	78	121	56	107	94	36
38	38	77	111	114	157	71	76	119	55	105	92	35
39	38	75	109	112	154	71	75	117	54	103	91	34

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
40	36	74	107	111	152	70	74	116	54	100	89	34
41	36	75	108	112	155	71	75	118	55	102	91	35
42	37	78	109	116	159	73	77	122	56	105	93	36
43	38	81	113	119	162	75	79	125	58	110	96	37
44	39	83	116	122	167	76	82	128	59	113	99	38
45	40	84	120	123	172	76	84	130	59	114	100	39
46	37	79	110	119	158	73	79	123	57	107	94	36
47	35	75	103	112	149	71	73	117	55	102	89	34
48	33	75	102	113	148	71	74	117	55	103	89	34
49	35	78	106	118	156	74	77	123	58	107	93	36
50	37	80	111	119	161	74	79	124	57	108	95	36
51	37	80	112	120	162	74	80	126	58	109	96	37
52	38	83	115	123	165	76	81	127	59	114	98	38
53	40	86	121	127	172	77	85	133	61	117	102	39
54	40	85	120	125	171	76	85	131	60	115	101	39
55	40	83	118	121	167	75	82	128	58	113	98	38
56	39	83	118	123	167	75	83	128	59	113	99	38
57	39	82	118	121	167	75	82	128	58	112	98	38
58	39	81	115	120	164	74	80	126	57	111	97	37
59	38	79	112	118	161	73	79	124	57	109	95	36
60	37	80	112	119	161	73	79	125	57	110	95	37
61	39	84	116	124	167	76	82	130	59	114	99	38
62	41	86	124	128	175	77	87	133	60	119	103	40
63	42	87	126	127	176	77	86	133	60	119	103	40
64	42	84	124	124	173	75	85	130	59	116	101	39
65	41	83	121	122	170	75	83	129	58	113	100	38
66	40	82	119	120	167	74	82	127	57	112	98	38
67	40	82	118	121	166	74	82	127	58	112	98	38
68	40	82	120	121	168	74	83	128	58	112	99	38
69	41	83	122	123	169	74	83	128	58	114	100	38
70	41	83	122	122	170	74	83	128	58	114	100	39
71	41	81	121	120	168	74	82	127	57	111	98	38
72	40	80	115	117	162	73	79	123	56	109	95	36
73	39	79	114	117	159	72	78	122	56	108	94	36
74	39	80	117	118	164	73	81	124	56	109	96	37
75	41	82	120	122	167	75	83	127	58	113	99	38
76	42	82	123	121	169	74	83	126	58	113	99	38
77	41	82	121	121	169	74	83	126	58	113	99	38
78	40	81	120	120	168	74	82	127	58	111	98	38
79	41	82	121	122	170	75	83	129	58	113	99	38

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
80	41	85	123	126	173	76	85	132	59	115	102	39
81	43	88	130	130	178	78	89	135	61	121	105	41
82	45	90	134	132	182	81	92	138	63	123	108	41
83	46	88	134	129	180	79	90	135	61	120	106	40
84	43	83	125	122	169	74	84	127	58	113	100	38
85	41	80	120	117	165	72	80	123	56	109	96	37
86	40	81	117	120	165	74	81	125	57	111	97	37
87	41	80	120	119	166	73	81	125	57	111	97	37
88	40	79	118	117	162	73	80	123	56	109	96	37
89	40	79	117	117	161	72	79	122	56	108	95	36
90	40	80	118	119	164	74	82	125	57	110	97	37
91	41	81	120	121	166	75	82	126	58	111	98	37
92	42	83	123	123	169	76	84	128	59	114	100	38
93	42	84	125	123	170	76	85	129	59	115	101	38
94	43	84	125	123	170	76	85	129	59	115	101	38
95	43	84	127	124	173	76	86	129	59	115	102	39
96	45	86	131	127	176	78	88	132	60	118	104	40
97	44	88	134	130	179	80	90	134	62	121	106	41
98	44	86	130	125	174	77	88	131	60	118	103	39
99	42	84	126	124	171	77	85	129	59	115	101	38
100	41	82	121	122	166	76	84	127	58	113	99	37
101	40	81	119	120	163	75	82	125	58	110	97	37
102	39	80	117	119	161	75	81	124	58	110	96	36
103	40	80	118	120	162	75	82	125	58	110	97	37
104	40	81	119	120	163	75	82	125	58	111	97	37
105	39	80	118	119	163	75	81	124	58	110	97	37
106	39	80	117	119	162	74	82	124	57	110	96	37
107	39	81	118	122	164	76	83	127	59	113	98	37
108	40	82	120	122	164	76	83	127	59	113	99	37
109	41	83	121	123	166	77	84	128	59	114	100	37
110	43	84	127	125	170	77	86	130	59	116	102	38
111	43	84	125	124	169	77	85	129	59	116	101	38
112	42	82	123	122	168	77	84	128	59	113	100	38
113	42	83	123	122	168	76	84	128	59	113	100	38
114	42	84	125	125	171	78	86	130	60	115	102	38
115	44	86	129	127	175	79	88	132	60	119	104	39
116	45	86	131	128	175	79	89	133	61	119	105	39
117	44	85	131	126	174	78	87	130	60	117	103	39
118	44	83	128	124	169	77	85	128	59	115	101	38
119	42	80	122	118	162	75	82	123	57	110	97	36

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
120	41	78	120	117	160	74	80	121	57	108	96	36
121	40	77	118	115	158	73	79	119	56	106	94	35
122	39	75	115	113	155	72	78	118	55	104	92	35
123	38	74	110	111	151	72	75	116	54	102	90	34
124	38	76	112	115	154	73	78	119	56	104	93	34
125	39	78	117	117	159	75	80	122	57	108	95	36
126	41	80	120	119	163	76	82	124	58	110	97	37
127	41	84	125	126	169	79	86	130	60	116	102	38
128	42	85	126	126	170	79	87	131	61	116	102	38
129	42	82	121	121	164	76	84	127	59	111	99	37
130	39	78	116	116	159	74	80	121	57	107	95	36
131	37	76	109	113	153	72	76	118	55	104	91	34
132	37	76	109	114	153	72	77	120	55	105	92	34
133	38	77	111	116	155	73	79	120	56	107	93	35
134	38	77	111	116	155	73	79	121	56	107	93	35
135	38	78	112	117	157	73	79	122	56	106	94	35
136	38	77	112	117	156	73	79	122	56	106	94	35
137	38	76	110	115	153	72	78	119	56	105	92	34
138	37	75	108	113	151	71	76	118	55	103	91	34
139	37	76	109	114	152	72	77	119	56	104	92	34
140	37	76	109	115	152	73	78	120	56	104	92	34
141	39	79	116	118	159	75	81	123	57	109	96	36
142	41	80	119	119	162	76	83	125	58	110	97	36
143	41	80	119	119	162	75	82	124	58	109	97	36
144	41	79	119	118	162	75	82	123	58	108	96	36
145	39	78	117	117	160	73	80	122	56	107	95	36
146	39	78	116	117	160	73	80	122	56	107	95	36
147	38	78	115	116	159	73	80	121	56	107	94	36
148	39	79	117	119	162	75	81	123	58	109	96	36
149	41	83	121	123	166	78	84	128	59	113	100	37
150	43	83	125	124	169	77	85	129	60	115	101	38
151	42	83	124	122	167	77	84	127	59	114	100	37
152	42	82	122	122	167	77	84	127	59	113	99	37
153	42	83	123	124	168	78	86	129	60	114	101	38
154	42	83	124	124	168	77	85	128	59	115	101	38
155	42	83	123	124	168	77	86	128	59	114	100	38
156	42	84	124	125	169	78	86	129	60	115	101	38
157	42	83	124	124	169	77	86	129	59	115	101	38
158	41	81	121	121	164	76	83	126	59	111	98	37
159	41	79	119	120	162	75	82	123	57	111	97	36

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
160	41	79	117	118	160	75	81	123	58	109	96	36
161	40	78	117	117	159	75	80	122	57	108	95	35
162	40	77	114	116	156	74	79	121	57	107	94	35
163	39	76	112	115	153	74	78	120	56	105	93	34
164	39	76	112	115	152	74	78	119	56	105	93	34
165	39	76	111	115	152	74	78	119	56	105	92	34
166	38	75	110	113	150	73	77	117	55	103	91	33
167	38	74	109	112	149	72	76	117	55	103	90	33
168	38	75	111	113	151	72	77	118	55	104	91	34
169	39	74	111	111	149	71	76	116	55	102	90	33
170	38	72	106	110	146	71	74	114	54	100	89	32
171	37	73	105	109	145	71	74	114	54	100	88	32
172	38	73	105	110	146	71	74	115	54	100	89	32
173	38	74	106	111	148	72	75	116	55	101	90	33
174	38	74	110	111	151	72	76	117	55	102	90	33
175	38	75	110	112	151	72	76	117	55	102	91	33
176	39	75	112	113	152	72	77	118	55	104	92	34
177	40	76	112	114	153	72	78	119	56	104	93	34
178	40	76	113	114	154	73	78	119	56	104	93	34
179	40	76	113	114	154	73	78	119	56	104	93	34
180	39	77	113	115	155	73	78	120	56	105	93	34
181	40	78	118	117	160	74	80	122	57	108	95	36
182	41	81	120	120	162	76	83	125	58	110	98	36
183	43	84	125	123	166	77	85	128	59	114	100	37
184	44	85	128	125	170	79	87	130	60	115	102	38
185	43	85	129	125	170	78	87	129	60	115	102	38
186	43	83	128	124	169	77	86	127	59	114	101	38
187	40	79	119	117	157	75	80	121	57	107	95	35
188	39	77	114	115	153	74	79	120	57	106	93	34
189	39	79	117	118	156	76	81	121	57	108	95	35
190	40	81	122	121	162	77	83	124	58	110	98	36
191	41	82	124	122	163	78	84	126	60	111	99	37
192	40	81	122	120	161	76	82	123	58	109	97	36
193	43	84	128	124	167	79	86	127	60	112	101	37
194	43	86	131	126	169	80	88	130	61	116	103	38
195	43	87	131	127	169	80	88	129	61	116	103	38
196	43	86	131	126	167	80	87	128	61	115	102	37
197	43	85	129	124	165	79	86	127	60	113	101	37
198	44	87	134	126	168	81	88	128	61	115	103	37
199	44	86	133	126	167	80	87	128	61	115	103	37

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
200	44	87	134	127	169	81	88	129	62	116	104	38
201	45	87	133	127	169	81	88	129	62	115	104	38
202	43	84	129	125	167	79	87	127	60	113	101	37
203	43	84	128	124	165	79	86	126	60	112	101	37
204	43	84	128	124	165	79	86	126	60	112	101	37
205	43	83	127	122	163	78	85	124	59	111	100	36
206	42	81	124	119	160	76	83	122	58	108	97	36
207	41	79	119	117	155	75	81	120	57	107	95	34
208	40	77	116	115	153	74	79	118	56	105	93	34
209	40	77	116	116	154	74	80	119	57	106	94	34
210	42	81	121	120	159	77	83	123	59	109	97	35
211	42	82	125	121	161	78	84	124	59	110	99	36
212	42	81	124	119	159	77	83	121	58	109	97	35
213	41	80	121	119	158	76	83	121	58	107	96	35
214	41	81	119	120	158	77	83	123	59	108	97	35
215	41	82	120	122	160	78	84	125	59	109	98	35
216	42	84	123	124	163	79	85	127	60	113	100	36
217	44	87	130	128	169	83	89	131	63	116	104	37
218	45	88	133	130	169	83	89	131	63	116	105	38
219	45	89	133	129	168	84	89	131	63	117	105	37
220	43	86	130	128	166	82	88	129	62	114	103	37
221	43	85	128	125	163	81	86	127	61	112	101	36
222	44	88	131	128	165	85	88	129	64	115	104	36
223	45	92	138	133	171	88	92	133	65	119	108	38
224	46	96	143	136	172	90	94	135	68	121	110	38
225	47	96	146	138	174	92	96	136	69	122	111	38
226	45	93	140	133	169	89	93	132	67	119	108	37
227	45	92	138	133	168	89	92	132	67	118	107	37
228	45	93	137	134	167	90	93	132	68	119	108	37
229	45	94	138	136	166	92	93	134	68	119	109	37
230	45	96	140	138	167	95	95	135	71	121	110	37
231	45	96	138	139	167	95	95	136	71	121	111	37
232	44	95	136	140	167	95	95	136	71	122	110	37
233	44	95	134	140	166	95	95	137	71	122	110	37
234	44	96	135	143	169	97	97	140	72	125	112	37
235	46	101	142	151	178	102	103	147	76	131	118	40
236	50	113	158	166	192	111	112	160	83	144	129	43



Table B2. Northern longshore transport rates, existing bathymetry, 1990–1999, 1,000 cu yd/yr.

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
1	-249	-172	-388	-342	-381	-460	-441	-179	-386	-535	-353	120
2	-233	-162	-366	-322	-361	-428	-414	-169	-365	-505	-333	113
3	-226	-159	-355	-311	-348	-412	-400	-163	-351	-485	-321	108
4	-220	-156	-348	-303	-340	-401	-389	-160	-344	-474	-314	105
5	-216	-156	-347	-299	-335	-394	-383	-158	-338	-465	-309	103
6	-213	-154	-344	-296	-333	-390	-379	-156	-334	-461	-306	102
7	-209	-154	-342	-294	-332	-385	-373	-153	-332	-460	-303	102
8	-207	-154	-342	-296	-334	-385	-372	-154	-333	-462	-304	102
9	-211	-161	-356	-306	-345	-394	-382	-157	-343	-480	-314	106
10	-221	-175	-378	-321	-360	-414	-400	-165	-361	-505	-330	111
11	-254	-209	-453	-381	-429	-486	-465	-191	-425	-604	-390	133
12	-271	-218	-465	-385	-427	-511	-485	-202	-432	-599	-399	131
13	-262	-196	-426	-358	-396	-484	-458	-192	-404	-554	-373	122
14	-244	-175	-386	-332	-369	-446	-428	-177	-375	-512	-344	113
15	-230	-162	-354	-307	-338	-415	-401	-166	-348	-470	-319	104
16	-219	-156	-348	-304	-340	-404	-390	-160	-343	-473	-314	105
17	-223	-165	-368	-318	-357	-415	-402	-164	-359	-500	-327	111
18	-234	-177	-385	-330	-366	-434	-418	-173	-371	-515	-340	113
19	-238	-180	-400	-346	-389	-446	-433	-175	-390	-548	-355	122
20	-237	-178	-396	-342	-384	-444	-429	-175	-385	-540	-351	120
21	-234	-176	-391	-339	-380	-442	-426	-172	-382	-536	-348	119
22	-235	-175	-391	-335	-378	-441	-423	-171	-380	-528	-346	118
23	-235	-175	-387	-333	-372	-439	-422	-172	-378	-524	-344	116
24	-238	-177	-392	-334	-374	-443	-426	-173	-379	-526	-346	117
25	-239	-175	-388	-333	-372	-446	-427	-174	-378	-521	-345	116
26	-234	-169	-376	-322	-362	-433	-416	-169	-366	-506	-335	113
27	-224	-161	-361	-314	-353	-412	-400	-162	-356	-493	-324	110
28	-216	-155	-353	-312	-354	-404	-393	-158	-352	-497	-320	111
29	-215	-158	-358	-314	-359	-405	-392	-157	-355	-505	-322	113
30	-220	-163	-368	-323	-369	-416	-401	-161	-366	-521	-331	116
31	-224	-169	-378	-329	-373	-422	-409	-165	-373	-528	-337	117
32	-219	-163	-371	-320	-368	-412	-399	-161	-365	-518	-330	115
33	-220	-169	-377	-323	-368	-414	-401	-163	-367	-519	-332	115
34	-228	-178	-390	-330	-372	-429	-414	-170	-374	-522	-341	115
35	-236	-179	-388	-325	-363	-435	-416	-173	-370	-508	-339	111
36	-229	-169	-371	-317	-354	-423	-406	-168	-361	-494	-329	109
37	-228	-166	-368	-316	-354	-420	-405	-166	-360	-494	-328	109
38	-227	-166	-370	-322	-362	-421	-409	-166	-365	-508	-332	113
39	-229	-169	-379	-329	-372	-426	-413	-167	-372	-521	-338	116

(Sheet 1 of 6)

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
40	-227	-167	-376	-327	-370	-423	-411	-166	-371	-521	-336	116
41	-225	-168	-376	-328	-370	-422	-409	-165	-372	-521	-336	116
42	-223	-168	-373	-322	-365	-417	-404	-164	-365	-512	-331	114
43	-215	-161	-359	-309	-350	-400	-388	-158	-351	-491	-318	109
44	-206	-155	-348	-299	-341	-385	-373	-152	-340	-475	-307	105
45	-206	-157	-351	-301	-348	-387	-375	-151	-343	-486	-310	108
46	-199	-151	-332	-280	-316	-368	-356	-147	-318	-440	-291	97
47	-209	-162	-352	-296	-332	-389	-374	-155	-336	-464	-307	102
48	-219	-172	-368	-306	-342	-406	-389	-162	-348	-479	-319	105
49	-224	-175	-377	-314	-352	-420	-399	-166	-358	-494	-328	108
50	-226	-174	-382	-323	-363	-427	-407	-166	-367	-511	-335	113
51	-235	-180	-396	-335	-378	-443	-424	-172	-382	-535	-348	118
52	-240	-182	-397	-335	-376	-449	-428	-175	-382	-529	-349	117
53	-237	-176	-388	-330	-373	-443	-422	-172	-377	-524	-344	116
54	-234	-172	-382	-328	-370	-437	-418	-169	-374	-521	-341	116
55	-232	-171	-380	-326	-369	-433	-416	-168	-372	-520	-339	116
56	-230	-169	-373	-320	-360	-423	-410	-167	-365	-505	-332	112
57	-225	-165	-369	-317	-359	-414	-402	-163	-362	-501	-328	111
58	-227	-168	-375	-324	-369	-422	-409	-165	-368	-517	-334	115
59	-232	-172	-387	-332	-376	-431	-416	-169	-376	-525	-341	116
60	-235	-175	-390	-334	-377	-437	-422	-172	-379	-527	-345	117
61	-240	-178	-392	-334	-376	-442	-427	-174	-381	-525	-347	116
62	-234	-169	-378	-326	-367	-430	-415	-169	-371	-511	-337	113
63	-228	-164	-371	-324	-370	-422	-410	-165	-369	-514	-334	115
64	-226	-164	-374	-326	-372	-421	-408	-163	-370	-519	-334	116
65	-232	-171	-387	-334	-384	-431	-420	-167	-382	-538	-345	120
66	-236	-175	-392	-337	-385	-438	-425	-171	-384	-540	-348	120
67	-234	-173	-384	-331	-373	-432	-418	-170	-375	-520	-341	115
68	-229	-167	-375	-323	-370	-423	-409	-166	-369	-514	-334	114
69	-227	-164	-371	-323	-368	-419	-407	-164	-367	-512	-332	114
70	-226	-164	-372	-325	-372	-420	-409	-164	-370	-518	-334	116
71	-232	-171	-385	-335	-386	-432	-420	-168	-383	-539	-345	120
72	-238	-175	-396	-342	-392	-442	-430	-172	-389	-548	-353	122
73	-241	-176	-392	-339	-383	-442	-430	-174	-385	-537	-350	119
74	-234	-169	-378	-329	-372	-431	-419	-169	-375	-522	-340	116
75	-229	-163	-367	-319	-362	-418	-407	-165	-363	-503	-329	112
76	-223	-158	-362	-317	-364	-410	-400	-161	-361	-507	-326	113
77	-221	-158	-361	-318	-365	-409	-399	-160	-363	-511	-327	114
78	-227	-166	-375	-328	-378	-421	-411	-165	-376	-531	-338	118
79	-233	-169	-381	-335	-382	-430	-420	-168	-381	-537	-344	119

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
80	-233	-167	-378	-329	-375	-428	-416	-168	-376	-523	-339	116
81	-228	-161	-363	-317	-360	-413	-405	-164	-362	-501	-327	111
82	-217	-150	-342	-301	-346	-393	-385	-155	-344	-478	-311	107
83	-208	-144	-330	-295	-341	-378	-372	-149	-338	-475	-303	106
84	-209	-146	-336	-303	-348	-381	-376	-150	-346	-488	-308	109
85	-223	-161	-367	-325	-375	-412	-403	-161	-373	-527	-333	117
86	-235	-170	-384	-338	-386	-432	-424	-170	-386	-542	-347	121
87	-232	-167	-381	-332	-382	-427	-417	-168	-379	-531	-342	118
88	-226	-164	-370	-322	-369	-415	-406	-164	-367	-514	-332	114
89	-225	-162	-367	-319	-366	-412	-403	-163	-364	-508	-329	113
90	-225	-163	-367	-318	-363	-411	-402	-163	-362	-504	-328	112
91	-224	-161	-363	-317	-362	-408	-401	-162	-361	-502	-326	112
92	-225	-159	-359	-316	-360	-409	-401	-162	-360	-501	-325	112
93	-223	-157	-357	-315	-358	-407	-399	-160	-357	-500	-323	112
94	-224	-157	-358	-316	-360	-409	-401	-161	-360	-504	-325	112
95	-223	-156	-355	-313	-357	-410	-398	-161	-357	-499	-323	112
96	-219	-150	-347	-308	-354	-400	-391	-157	-351	-491	-317	110
97	-202	-134	-309	-272	-311	-361	-353	-144	-312	-429	-283	96
98	-201	-136	-316	-282	-324	-367	-359	-145	-322	-450	-290	101
99	-207	-142	-327	-290	-333	-377	-369	-148	-332	-464	-299	104
100	-208	-144	-329	-291	-333	-378	-370	-150	-333	-463	-300	103
101	-209	-145	-331	-291	-334	-379	-370	-151	-333	-464	-301	103
102	-210	-145	-330	-290	-332	-378	-371	-151	-332	-459	-300	102
103	-211	-145	-330	-291	-332	-379	-371	-151	-332	-460	-300	102
104	-209	-143	-328	-291	-333	-375	-369	-151	-332	-461	-299	103
105	-208	-144	-328	-291	-336	-373	-368	-150	-335	-466	-300	103
106	-211	-147	-336	-296	-340	-380	-374	-152	-339	-473	-305	105
107	-211	-149	-336	-293	-335	-377	-372	-153	-336	-462	-302	102
108	-209	-144	-328	-290	-332	-375	-369	-151	-329	-459	-299	102
109	-205	-141	-320	-282	-323	-365	-360	-148	-323	-444	-291	98
110	-201	-137	-317	-280	-324	-361	-356	-145	-320	-447	-289	100
111	-202	-139	-318	-283	-328	-363	-360	-145	-325	-456	-292	101
112	-205	-140	-323	-289	-335	-371	-365	-147	-330	-469	-297	105
113	-208	-146	-333	-295	-343	-378	-372	-150	-338	-478	-304	107
114	-212	-147	-338	-300	-348	-386	-379	-153	-342	-482	-309	108
115	-213	-146	-335	-297	-343	-385	-378	-153	-339	-476	-306	106
116	-207	-140	-324	-288	-333	-372	-367	-149	-329	-459	-297	102
117	-204	-134	-317	-284	-330	-367	-361	-146	-324	-455	-292	102
118	-203	-134	-315	-285	-330	-367	-360	-146	-324	-457	-292	102
119	-204	-138	-320	-288	-333	-368	-364	-147	-330	-463	-296	104

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
120	-206	-139	-321	-289	-333	-369	-366	-148	-330	-464	-296	103
121	-203	-138	-318	-286	-329	-363	-361	-147	-326	-457	-293	102
122	-200	-137	-313	-283	-324	-356	-356	-145	-323	-451	-289	100
123	-204	-141	-322	-290	-332	-367	-364	-148	-330	-464	-296	103
124	-206	-142	-324	-288	-333	-371	-366	-149	-330	-461	-297	102
125	-204	-140	-319	-283	-326	-362	-360	-147	-324	-451	-292	100
126	-200	-137	-313	-280	-323	-357	-355	-145	-320	-448	-288	99
127	-188	-125	-286	-255	-292	-330	-328	-136	-291	-401	-263	89
128	-187	-124	-287	-256	-295	-330	-328	-134	-292	-405	-264	90
129	-184	-124	-287	-257	-297	-327	-326	-133	-294	-409	-264	91
130	-189	-131	-299	-268	-309	-338	-336	-137	-306	-428	-274	95
131	-199	-140	-318	-281	-325	-360	-354	-145	-321	-452	-289	100
132	-203	-142	-321	-283	-326	-363	-358	-148	-323	-449	-292	99
133	-198	-138	-314	-276	-318	-352	-350	-143	-314	-437	-284	96
134	-197	-137	-313	-275	-318	-350	-349	-143	-315	-439	-284	97
135	-200	-140	-317	-279	-322	-355	-353	-145	-319	-444	-287	98
136	-199	-140	-318	-279	-323	-356	-353	-145	-320	-445	-288	98
137	-199	-140	-317	-279	-322	-355	-351	-145	-317	-443	-287	98
138	-199	-140	-316	-277	-319	-354	-351	-145	-316	-438	-286	96
139	-201	-142	-318	-278	-317	-355	-353	-147	-316	-434	-286	95
140	-202	-141	-315	-277	-317	-356	-352	-147	-315	-435	-286	95
141	-198	-135	-307	-272	-311	-348	-347	-144	-309	-425	-280	94
142	-195	-132	-302	-271	-311	-345	-344	-142	-307	-427	-278	94
143	-195	-134	-303	-272	-314	-345	-344	-142	-310	-432	-279	95
144	-194	-134	-304	-273	-313	-344	-344	-141	-312	-433	-279	96
145	-193	-134	-304	-273	-313	-345	-344	-140	-312	-435	-279	96
146	-194	-135	-308	-274	-314	-344	-345	-141	-312	-434	-280	96
147	-194	-136	-308	-273	-314	-343	-345	-141	-313	-435	-280	96
148	-196	-137	-310	-275	-316	-346	-347	-143	-315	-436	-282	96
149	-193	-133	-301	-271	-310	-339	-341	-141	-310	-426	-277	94
150	-191	-128	-295	-270	-307	-331	-337	-138	-308	-422	-273	93
151	-192	-133	-300	-272	-311	-334	-340	-140	-312	-430	-276	95
152	-193	-135	-304	-272	-311	-336	-341	-141	-313	-430	-277	94
153	-189	-127	-292	-263	-302	-327	-331	-137	-303	-415	-268	92
154	-182	-124	-283	-255	-292	-314	-321	-133	-293	-399	-260	88
155	-179	-123	-279	-252	-288	-308	-315	-131	-289	-392	-256	86
156	-178	-123	-278	-250	-287	-307	-313	-130	-288	-391	-254	86
157	-177	-122	-278	-250	-286	-306	-311	-129	-287	-391	-254	86
158	-178	-123	-281	-253	-291	-308	-316	-130	-291	-400	-257	88
159	-184	-128	-291	-262	-301	-321	-326	-135	-301	-414	-266	91

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
160	-188	-131	-298	-265	-307	-328	-332	-138	-306	-420	-271	92
161	-186	-131	-296	-264	-305	-326	-331	-136	-303	-419	-270	92
162	-186	-129	-293	-263	-303	-323	-329	-136	-302	-417	-268	92
163	-189	-133	-301	-267	-308	-328	-334	-138	-308	-423	-273	92
164	-190	-135	-303	-268	-308	-331	-335	-139	-308	-421	-274	92
165	-188	-131	-298	-263	-306	-328	-331	-137	-303	-415	-270	91
166	-187	-131	-296	-261	-302	-325	-328	-137	-300	-410	-268	90
167	-188	-132	-299	-263	-305	-328	-332	-137	-303	-414	-270	91
168	-191	-135	-306	-269	-311	-334	-337	-140	-308	-423	-275	93
169	-194	-138	-311	-276	-318	-342	-344	-142	-315	-435	-281	96
170	-197	-141	-317	-283	-324	-350	-352	-145	-322	-447	-288	98
171	-203	-147	-328	-289	-332	-359	-361	-149	-330	-457	-296	100
172	-205	-148	-331	-291	-336	-363	-366	-151	-333	-461	-298	101
173	-207	-148	-333	-292	-337	-365	-366	-151	-333	-460	-299	101
174	-207	-147	-329	-290	-334	-365	-365	-151	-330	-457	-298	100
175	-206	-146	-325	-289	-331	-364	-364	-151	-326	-455	-296	99
176	-207	-144	-323	-288	-327	-363	-363	-151	-325	-446	-294	98
177	-208	-144	-324	-290	-329	-365	-365	-151	-327	-448	-295	99
178	-208	-145	-325	-291	-332	-366	-367	-151	-330	-454	-297	100
179	-210	-147	-328	-294	-333	-369	-371	-153	-333	-456	-299	100
180	-211	-147	-328	-293	-332	-369	-372	-154	-332	-454	-299	100
181	-211	-144	-324	-290	-329	-367	-369	-152	-329	-450	-296	99
182	-212	-142	-320	-290	-325	-368	-370	-154	-328	-447	-296	98
183	-209	-139	-314	-282	-319	-360	-362	-151	-320	-435	-289	96
184	-204	-132	-300	-274	-310	-347	-352	-147	-310	-421	-280	93
185	-197	-127	-290	-266	-301	-337	-340	-142	-302	-409	-271	90
186	-194	-124	-286	-263	-298	-331	-336	-139	-299	-406	-268	90
187	-190	-122	-276	-247	-278	-319	-321	-137	-281	-377	-255	82
188	-190	-123	-276	-247	-278	-320	-323	-138	-283	-379	-256	83
189	-189	-122	-275	-247	-278	-317	-323	-137	-284	-379	-255	83
190	-191	-122	-277	-252	-285	-321	-326	-138	-287	-388	-259	85
191	-191	-122	-277	-253	-287	-319	-325	-139	-289	-389	-259	85
192	-191	-123	-279	-255	-289	-318	-325	-139	-290	-389	-260	85
193	-194	-125	-283	-262	-293	-318	-332	-141	-299	-395	-264	86
194	-193	-123	-279	-257	-288	-313	-327	-140	-292	-385	-260	84
195	-188	-119	-268	-247	-277	-301	-317	-136	-283	-368	-250	80
196	-183	-114	-260	-240	-268	-291	-307	-133	-274	-355	-243	77
197	-178	-112	-253	-232	-260	-281	-298	-131	-266	-343	-235	74
198	-173	-109	-246	-228	-253	-269	-292	-127	-261	-333	-229	72
199	-168	-106	-237	-220	-243	-257	-281	-123	-253	-320	-221	68

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
200	-163	-104	-233	-215	-238	-249	-273	-121	-247	-313	-216	67
201	-162	-105	-234	-216	-239	-249	-272	-121	-247	-312	-216	66
202	-164	-107	-236	-217	-241	-253	-275	-122	-248	-317	-218	67
203	-161	-104	-232	-211	-237	-247	-269	-119	-243	-309	-213	66
204	-157	-102	-226	-206	-229	-242	-263	-116	-236	-301	-208	64
205	-157	-102	-227	-206	-230	-241	-263	-116	-236	-301	-208	64
206	-157	-105	-231	-207	-233	-242	-265	-117	-238	-305	-210	64
207	-157	-108	-233	-209	-234	-245	-265	-118	-240	-309	-212	65
208	-157	-108	-234	-208	-234	-246	-266	-118	-241	-308	-212	65
209	-158	-108	-235	-208	-234	-247	-266	-119	-240	-307	-212	64
210	-160	-109	-238	-213	-239	-251	-271	-120	-245	-315	-216	66
211	-157	-105	-232	-205	-232	-246	-265	-117	-237	-304	-210	64
212	-148	-98	-217	-196	-220	-231	-251	-111	-224	-287	-198	61
213	-147	-98	-216	-195	-218	-229	-249	-109	-224	-288	-197	61
214	-150	-100	-222	-200	-225	-236	-255	-112	-228	-299	-203	63
215	-156	-104	-233	-209	-235	-250	-266	-116	-240	-314	-212	67
216	-161	-107	-238	-213	-240	-257	-273	-119	-245	-318	-217	68
217	-161	-105	-234	-211	-237	-254	-270	-119	-240	-312	-214	66
218	-159	-101	-227	-205	-229	-247	-265	-117	-233	-303	-209	64
219	-156	-99	-223	-201	-225	-243	-260	-115	-230	-294	-205	63
220	-157	-99	-222	-202	-225	-242	-260	-116	-230	-296	-205	63
221	-158	-101	-224	-203	-227	-244	-262	-117	-232	-299	-207	63
222	-157	-99	-220	-197	-218	-240	-257	-116	-226	-282	-201	60
223	-150	-93	-206	-186	-203	-225	-244	-112	-212	-260	-189	55
224	-141	-85	-188	-171	-186	-207	-225	-105	-195	-234	-174	49
225	-133	-81	-178	-162	-175	-192	-211	-100	-184	-221	-164	46
226	-130	-79	-175	-159	-173	-188	-209	-97	-183	-221	-162	46
227	-130	-80	-176	-158	-173	-188	-208	-98	-182	-219	-161	45
228	-129	-79	-172	-155	-168	-184	-204	-97	-179	-211	-158	44
229	-125	-76	-165	-151	-164	-177	-198	-94	-173	-204	-153	42
230	-121	-74	-161	-146	-159	-172	-192	-92	-168	-199	-148	41
231	-118	-73	-158	-143	-156	-166	-188	-90	-165	-194	-145	40
232	-116	-72	-158	-141	-154	-163	-184	-89	-163	-191	-143	39
233	-116	-72	-157	-140	-154	-163	-184	-89	-164	-192	-143	39
234	-118	-75	-160	-141	-156	-165	-186	-90	-165	-195	-145	40
235	-123	-78	-167	-144	-160	-170	-190	-94	-170	-199	-149	40
236	-124	-77	-164	-141	-156	-169	-188	-95	-168	-192	-147	38

(Sheet 6 of 6)

Table B3. Net longshore transport rates, existing bathymetry, 1990–1999, 1,000 cu yd/yr.

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
1	-209	-93	-272	-225	-219	-388	-362	-56	-329	-427	-258	122
2	-195	-84	-253	-207	-202	-357	-337	-49	-309	-398	-239	115
3	-188	-82	-246	-197	-193	-342	-323	-44	-296	-380	-229	110
4	-183	-81	-241	-190	-187	-331	-314	-41	-289	-371	-223	107
5	-180	-82	-243	-189	-186	-325	-309	-42	-284	-364	-220	105
6	-177	-80	-240	-186	-185	-322	-305	-41	-281	-360	-218	104
7	-174	-83	-240	-188	-187	-318	-302	-42	-280	-362	-218	103
8	-174	-86	-246	-193	-195	-319	-304	-45	-282	-369	-221	103
9	-181	-96	-266	-208	-214	-331	-318	-54	-294	-391	-235	106
10	-192	-112	-296	-226	-236	-351	-338	-65	-312	-419	-255	110
11	-225	-145	-372	-284	-304	-422	-404	-89	-377	-518	-314	132
12	-238	-146	-372	-277	-286	-441	-416	-88	-379	-503	-315	132
13	-226	-120	-321	-243	-243	-413	-383	-72	-348	-449	-282	124
14	-204	-96	-271	-214	-208	-374	-349	-54	-318	-404	-249	116
15	-193	-87	-244	-196	-184	-346	-325	-50	-294	-366	-228	107
16	-183	-86	-245	-199	-195	-338	-319	-50	-291	-377	-228	107
17	-189	-98	-271	-217	-220	-350	-336	-58	-308	-408	-246	111
18	-201	-108	-292	-228	-229	-367	-352	-65	-320	-423	-259	114
19	-202	-107	-299	-239	-243	-377	-362	-62	-337	-450	-268	122
20	-201	-104	-293	-233	-235	-374	-357	-59	-331	-440	-263	120
21	-198	-100	-284	-225	-225	-371	-350	-52	-327	-434	-257	120
22	-198	-98	-282	-220	-220	-369	-346	-50	-324	-424	-253	119
23	-197	-96	-276	-216	-212	-367	-344	-49	-321	-416	-249	118
24	-200	-98	-279	-216	-213	-370	-347	-50	-322	-417	-251	118
25	-200	-94	-275	-214	-210	-373	-348	-49	-320	-411	-249	118
26	-194	-88	-258	-202	-196	-359	-335	-43	-309	-396	-238	115
27	-184	-82	-244	-197	-191	-341	-321	-41	-301	-385	-229	112
28	-178	-81	-243	-203	-201	-335	-319	-42	-299	-396	-230	112
29	-179	-87	-254	-208	-211	-338	-320	-46	-303	-408	-235	113
30	-185	-91	-267	-217	-224	-347	-331	-50	-313	-424	-245	116
31	-189	-96	-276	-220	-224	-351	-337	-50	-319	-428	-249	117
32	-184	-89	-267	-211	-218	-342	-326	-45	-310	-417	-241	115
33	-186	-95	-276	-214	-220	-344	-329	-48	-313	-420	-244	115
34	-194	-103	-288	-217	-222	-357	-340	-52	-319	-420	-251	116
35	-200	-101	-282	-207	-208	-361	-339	-51	-312	-400	-246	113
36	-192	-91	-260	-199	-195	-350	-328	-45	-305	-387	-235	112
37	-190	-88	-257	-200	-196	-347	-327	-44	-304	-386	-234	111
38	-189	-89	-259	-209	-205	-349	-333	-47	-310	-402	-239	114
39	-191	-94	-270	-217	-218	-356	-338	-50	-318	-418	-247	116

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
40	-191	-93	-269	-217	-218	-353	-337	-50	-317	-421	-247	117
41	-189	-93	-268	-215	-216	-351	-334	-48	-317	-419	-245	117
42	-186	-90	-264	-206	-206	-344	-326	-42	-309	-407	-238	115
43	-177	-80	-246	-189	-188	-324	-309	-32	-293	-382	-222	110
44	-167	-72	-231	-176	-174	-309	-292	-23	-281	-362	-209	107
45	-165	-73	-231	-178	-176	-310	-291	-21	-284	-372	-210	109
46	-163	-72	-222	-161	-157	-295	-277	-24	-261	-332	-196	99
47	-174	-88	-249	-184	-184	-319	-301	-38	-282	-362	-218	103
48	-185	-98	-267	-193	-194	-335	-316	-44	-293	-376	-230	106
49	-189	-96	-270	-196	-195	-347	-322	-43	-300	-387	-234	111
50	-189	-94	-271	-203	-202	-353	-328	-42	-310	-403	-240	115
51	-198	-99	-284	-215	-216	-368	-344	-46	-324	-426	-252	120
52	-202	-99	-283	-212	-210	-373	-346	-47	-323	-415	-251	119
53	-197	-91	-267	-203	-201	-365	-337	-39	-316	-408	-242	119
54	-194	-87	-262	-203	-199	-360	-334	-38	-314	-406	-240	118
55	-192	-88	-262	-205	-202	-358	-335	-40	-314	-408	-240	118
56	-191	-86	-255	-197	-193	-348	-327	-39	-306	-393	-234	114
57	-186	-83	-250	-196	-192	-340	-320	-36	-304	-389	-230	113
58	-188	-87	-260	-204	-205	-349	-329	-39	-311	-407	-238	116
59	-194	-93	-274	-213	-215	-357	-337	-45	-320	-416	-247	117
60	-198	-95	-278	-215	-216	-364	-343	-47	-322	-417	-249	118
61	-201	-94	-275	-211	-209	-366	-344	-44	-322	-411	-248	118
62	-193	-83	-254	-198	-192	-352	-328	-35	-310	-392	-234	116
63	-186	-77	-246	-197	-194	-346	-323	-31	-309	-395	-230	117
64	-184	-80	-250	-202	-200	-346	-324	-33	-312	-403	-233	117
65	-191	-88	-267	-212	-213	-357	-337	-38	-323	-425	-245	121
66	-196	-93	-274	-217	-219	-364	-343	-44	-327	-428	-251	121
67	-194	-91	-266	-210	-206	-358	-336	-43	-317	-408	-243	117
68	-189	-84	-256	-202	-202	-349	-327	-38	-311	-402	-236	116
69	-187	-82	-249	-200	-199	-345	-324	-36	-309	-398	-233	116
70	-185	-82	-250	-202	-201	-346	-325	-36	-312	-404	-234	117
71	-192	-90	-264	-215	-218	-359	-338	-41	-326	-428	-247	121
72	-198	-95	-281	-225	-230	-370	-351	-49	-333	-439	-257	123
73	-202	-97	-278	-222	-224	-370	-352	-52	-329	-429	-256	120
74	-195	-89	-261	-211	-208	-358	-338	-45	-319	-413	-244	118
75	-188	-80	-247	-197	-194	-343	-324	-38	-305	-390	-231	114
76	-181	-76	-239	-196	-195	-335	-317	-34	-303	-394	-227	114
77	-181	-76	-239	-197	-197	-335	-316	-34	-306	-399	-228	115
78	-187	-85	-255	-208	-210	-346	-328	-38	-318	-420	-240	119
79	-192	-87	-260	-213	-212	-355	-336	-39	-323	-424	-244	121



Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
80	-192	-82	-255	-203	-202	-351	-331	-37	-317	-408	-238	118
81	-185	-73	-233	-188	-182	-335	-316	-28	-301	-380	-222	114
82	-171	-60	-208	-169	-164	-312	-293	-17	-282	-356	-203	110
83	-162	-56	-196	-166	-161	-300	-282	-14	-276	-354	-197	108
84	-166	-64	-211	-181	-178	-306	-292	-23	-288	-375	-209	110
85	-182	-81	-247	-208	-210	-339	-323	-39	-316	-417	-236	118
86	-194	-89	-267	-218	-222	-358	-343	-45	-328	-431	-249	121
87	-192	-86	-261	-213	-216	-354	-336	-43	-322	-421	-244	119
88	-187	-84	-252	-204	-207	-342	-326	-41	-310	-405	-236	115
89	-186	-83	-250	-203	-205	-339	-324	-41	-308	-400	-234	114
90	-185	-82	-248	-199	-199	-337	-321	-38	-305	-394	-231	113
91	-183	-79	-243	-197	-195	-333	-319	-35	-304	-391	-228	113
92	-184	-76	-236	-192	-191	-333	-317	-33	-301	-387	-225	113
93	-181	-73	-232	-191	-188	-331	-314	-32	-299	-385	-223	113
94	-181	-73	-233	-193	-189	-333	-316	-32	-301	-389	-224	114
95	-180	-71	-228	-189	-184	-334	-313	-31	-299	-384	-221	114
96	-174	-64	-216	-182	-178	-322	-303	-25	-290	-373	-213	112
97	-158	-46	-174	-142	-131	-281	-263	-10	-250	-308	-177	100
98	-158	-50	-186	-156	-150	-290	-271	-13	-263	-332	-187	104
99	-164	-58	-202	-166	-162	-301	-284	-19	-273	-349	-198	106
100	-167	-62	-207	-170	-167	-302	-287	-23	-274	-350	-201	105
101	-169	-64	-212	-171	-171	-304	-289	-25	-275	-354	-203	105
102	-171	-65	-213	-171	-171	-304	-289	-27	-274	-350	-204	104
103	-171	-65	-212	-171	-170	-304	-289	-26	-275	-350	-203	104
104	-169	-63	-209	-171	-170	-300	-287	-25	-274	-351	-202	104
105	-169	-64	-211	-172	-173	-298	-287	-26	-278	-356	-203	105
106	-172	-68	-220	-176	-179	-306	-293	-28	-282	-363	-209	106
107	-172	-68	-218	-170	-171	-301	-289	-27	-277	-350	-204	104
108	-169	-62	-208	-168	-168	-299	-286	-24	-271	-346	-200	104
109	-164	-58	-199	-159	-157	-288	-275	-20	-263	-331	-191	101
110	-158	-53	-191	-155	-154	-284	-270	-15	-261	-331	-187	102
111	-159	-55	-193	-159	-158	-285	-274	-17	-266	-340	-191	103
112	-162	-58	-200	-167	-168	-294	-281	-19	-271	-356	-198	106
113	-166	-63	-210	-173	-175	-302	-288	-22	-279	-365	-204	108
114	-170	-64	-213	-175	-177	-308	-293	-23	-283	-367	-207	109
115	-169	-60	-206	-170	-168	-307	-291	-21	-278	-357	-203	108
116	-162	-54	-192	-160	-158	-293	-278	-16	-268	-340	-192	104
117	-160	-50	-186	-158	-156	-289	-273	-16	-264	-338	-189	104
118	-160	-51	-187	-161	-161	-290	-274	-18	-265	-342	-191	104
119	-162	-58	-198	-170	-171	-293	-283	-24	-273	-353	-199	105

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
120	-165	-60	-200	-172	-174	-295	-286	-27	-274	-357	-201	104
121	-162	-61	-200	-171	-171	-290	-282	-27	-270	-351	-199	103
122	-161	-62	-199	-170	-170	-284	-279	-27	-268	-347	-197	101
123	-166	-67	-211	-178	-180	-296	-288	-33	-275	-362	-206	103
124	-168	-66	-213	-173	-178	-297	-288	-30	-274	-357	-205	104
125	-164	-62	-202	-166	-167	-288	-280	-26	-266	-344	-196	101
126	-159	-57	-194	-161	-160	-281	-273	-20	-262	-338	-190	101
127	-147	-41	-162	-129	-123	-251	-242	-6	-231	-285	-162	92
128	-144	-39	-161	-129	-125	-251	-241	-4	-232	-289	-161	93
129	-143	-42	-166	-136	-133	-251	-243	-6	-235	-298	-165	93
130	-150	-54	-183	-151	-150	-264	-256	-16	-249	-321	-180	96
131	-162	-64	-209	-169	-173	-288	-278	-26	-266	-348	-198	101
132	-165	-66	-212	-169	-173	-291	-281	-28	-267	-345	-200	101
133	-160	-61	-202	-160	-163	-279	-272	-23	-259	-330	-191	98
134	-159	-60	-202	-159	-162	-277	-270	-23	-259	-333	-190	98
135	-162	-62	-205	-162	-166	-282	-274	-23	-262	-337	-194	99
136	-161	-62	-206	-162	-166	-283	-274	-23	-264	-339	-194	100
137	-161	-63	-207	-164	-169	-283	-274	-25	-262	-338	-195	99
138	-162	-65	-208	-165	-168	-282	-275	-27	-261	-335	-195	98
139	-164	-66	-210	-164	-165	-283	-275	-28	-261	-330	-195	97
140	-164	-65	-206	-163	-165	-283	-274	-27	-260	-331	-194	97
141	-159	-56	-191	-154	-152	-273	-266	-22	-252	-316	-184	95
142	-154	-52	-183	-151	-149	-269	-261	-17	-249	-317	-180	96
143	-154	-54	-184	-154	-152	-270	-263	-18	-253	-323	-182	97
144	-153	-55	-186	-155	-151	-269	-263	-18	-254	-325	-183	97
145	-154	-56	-187	-156	-154	-272	-264	-19	-256	-328	-185	98
146	-156	-57	-192	-157	-154	-271	-265	-20	-255	-326	-185	97
147	-156	-58	-193	-157	-155	-270	-265	-20	-257	-328	-186	97
148	-156	-57	-193	-157	-154	-271	-266	-19	-257	-327	-186	98
149	-152	-50	-180	-148	-144	-262	-257	-13	-251	-313	-177	96
150	-148	-45	-170	-146	-138	-254	-251	-9	-248	-308	-172	96
151	-149	-50	-176	-150	-144	-257	-255	-12	-252	-316	-176	96
152	-151	-52	-182	-150	-145	-259	-257	-14	-254	-317	-178	96
153	-147	-44	-169	-139	-134	-249	-245	-8	-243	-301	-168	94
154	-140	-41	-159	-131	-124	-236	-236	-5	-234	-284	-159	90
155	-137	-40	-156	-128	-120	-231	-230	-3	-230	-278	-155	89
156	-136	-39	-154	-126	-118	-229	-227	-1	-228	-276	-153	89
157	-135	-39	-154	-126	-118	-229	-225	-1	-227	-276	-153	88
158	-137	-43	-160	-132	-127	-232	-232	-4	-233	-289	-159	90
159	-144	-49	-172	-142	-139	-246	-244	-11	-243	-303	-169	92

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
160	-148	-53	-181	-147	-147	-253	-251	-15	-248	-311	-175	94
161	-146	-53	-179	-147	-146	-251	-250	-14	-246	-310	-174	93
162	-146	-53	-179	-147	-147	-249	-249	-15	-246	-310	-174	93
163	-149	-57	-188	-152	-154	-254	-256	-18	-252	-317	-180	94
164	-151	-58	-191	-153	-156	-257	-257	-20	-252	-316	-181	93
165	-150	-55	-187	-149	-154	-254	-254	-18	-247	-310	-178	92
166	-149	-56	-186	-148	-152	-252	-252	-20	-245	-307	-177	91
167	-150	-58	-190	-151	-156	-256	-256	-21	-248	-311	-180	92
168	-153	-60	-195	-155	-161	-262	-260	-23	-253	-320	-184	94
169	-155	-64	-200	-164	-169	-271	-269	-26	-260	-333	-191	96
170	-159	-69	-210	-173	-178	-279	-277	-31	-268	-346	-199	98
171	-166	-74	-223	-180	-187	-288	-287	-35	-276	-357	-207	100
172	-168	-75	-226	-181	-190	-292	-292	-35	-279	-361	-210	102
173	-169	-75	-227	-181	-188	-293	-291	-35	-278	-359	-210	102
174	-168	-73	-219	-179	-183	-294	-289	-35	-275	-355	-207	101
175	-167	-72	-215	-177	-180	-293	-288	-34	-271	-352	-205	100
176	-168	-68	-212	-175	-175	-291	-286	-33	-270	-342	-202	99
177	-168	-68	-212	-175	-175	-293	-287	-32	-272	-344	-203	100
178	-168	-69	-212	-176	-177	-294	-289	-32	-274	-349	-204	101
179	-170	-70	-215	-179	-178	-296	-293	-33	-277	-352	-206	102
180	-172	-70	-215	-179	-177	-296	-293	-33	-275	-350	-206	101
181	-171	-66	-206	-173	-169	-293	-289	-30	-272	-343	-201	101
182	-171	-62	-200	-169	-163	-293	-287	-28	-270	-337	-198	101
183	-166	-56	-189	-158	-152	-283	-277	-23	-261	-321	-189	98
184	-160	-48	-172	-150	-140	-269	-265	-17	-250	-306	-178	96
185	-153	-42	-162	-141	-131	-259	-254	-13	-242	-294	-169	94
186	-151	-40	-158	-139	-129	-254	-251	-12	-240	-292	-167	93
187	-150	-44	-157	-130	-122	-245	-241	-16	-224	-270	-160	86
188	-151	-45	-161	-132	-125	-246	-244	-18	-226	-273	-162	86
189	-150	-43	-158	-130	-122	-242	-242	-16	-226	-271	-160	86
190	-150	-41	-155	-132	-124	-244	-243	-14	-229	-278	-161	89
191	-150	-39	-153	-131	-124	-241	-241	-13	-229	-278	-160	88
192	-151	-41	-157	-136	-128	-242	-243	-16	-233	-280	-163	88
193	-151	-42	-154	-138	-126	-239	-246	-14	-239	-283	-163	89
194	-149	-37	-148	-130	-119	-233	-240	-11	-230	-269	-157	87
195	-144	-32	-137	-121	-109	-220	-230	-7	-222	-252	-147	84
196	-140	-29	-129	-114	-101	-211	-220	-5	-213	-239	-140	81
197	-136	-27	-124	-108	-94	-201	-212	-4	-205	-230	-134	79
198	-128	-22	-113	-102	-85	-188	-204	1	-200	-218	-126	77
199	-124	-20	-104	-95	-76	-177	-194	4	-192	-206	-118	74

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
200	-119	-17	-98	-88	-70	-168	-185	8	-185	-197	-112	72
201	-118	-18	-101	-88	-69	-168	-184	8	-185	-197	-112	72
202	-121	-22	-106	-92	-74	-174	-189	5	-188	-204	-116	73
203	-118	-20	-104	-87	-71	-168	-183	7	-183	-196	-112	71
204	-114	-18	-99	-82	-64	-163	-177	10	-176	-188	-107	70
205	-114	-19	-100	-84	-67	-163	-178	8	-177	-191	-108	69
206	-115	-24	-107	-88	-73	-166	-182	5	-180	-196	-113	69
207	-116	-28	-114	-92	-79	-170	-185	2	-183	-202	-117	69
208	-118	-31	-118	-94	-81	-172	-187	0	-185	-203	-119	69
209	-118	-31	-119	-92	-80	-172	-186	1	-183	-201	-118	69
210	-117	-28	-117	-93	-79	-174	-188	3	-187	-206	-119	71
211	-115	-23	-108	-84	-70	-168	-181	7	-178	-195	-111	70
212	-107	-18	-92	-76	-61	-154	-168	11	-166	-178	-101	66
213	-106	-18	-95	-76	-60	-153	-166	12	-166	-181	-101	66
214	-109	-20	-103	-80	-67	-159	-172	11	-170	-191	-106	68
215	-115	-23	-112	-87	-75	-172	-182	9	-181	-204	-114	72
216	-119	-23	-114	-90	-77	-177	-188	7	-185	-205	-117	73
217	-116	-18	-104	-83	-68	-171	-182	12	-177	-196	-110	72
218	-114	-13	-94	-76	-60	-164	-175	14	-170	-187	-104	71
219	-112	-11	-89	-72	-57	-159	-170	15	-167	-177	-100	69
220	-114	-13	-93	-74	-59	-160	-172	13	-167	-182	-102	69
221	-116	-16	-96	-78	-64	-163	-176	9	-170	-186	-106	69
222	-113	-12	-89	-69	-53	-155	-168	13	-163	-167	-98	67
223	-105	-1	-67	-53	-32	-138	-152	22	-146	-141	-81	64
224	-94	10	-44	-35	-14	-116	-131	30	-127	-113	-63	60
225	-86	15	-32	-24	-2	-100	-116	36	-116	-99	-52	57
226	-85	14	-35	-26	-4	-99	-116	34	-116	-102	-53	57
227	-85	12	-38	-25	-5	-99	-116	34	-114	-102	-54	56
228	-84	14	-35	-21	-1	-94	-112	36	-111	-93	-50	55
229	-81	18	-27	-15	2	-85	-104	39	-105	-85	-44	54
230	-76	22	-20	-8	8	-77	-97	43	-97	-78	-38	53
231	-74	24	-20	-4	12	-71	-92	46	-94	-73	-35	52
232	-72	23	-22	-1	13	-68	-89	47	-92	-69	-33	51
233	-72	23	-24	1	12	-67	-89	48	-93	-71	-33	51
234	-74	21	-25	2	14	-68	-89	49	-93	-71	-33	52
235	-77	24	-24	7	18	-68	-88	54	-95	-67	-32	54
236	-74	36	-6	25	36	-58	-77	65	-85	-48	-18	56

(Sheet 6 of 6)

Table B4. Gross longshore transport rates, existing bathymetry, 1990–1999, 1,000 cu yd/yr.

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
1	288	252	504	459	543	532	520	302	442	644	449	128
2	271	240	479	437	520	499	492	289	420	611	426	122
3	263	235	464	424	503	483	476	282	406	590	413	116
4	256	232	456	416	493	471	465	278	398	577	404	114
5	251	230	452	409	484	463	457	273	391	566	398	111
6	248	228	447	405	481	459	452	271	387	562	394	111
7	243	225	443	401	477	452	444	265	384	557	389	111
8	240	223	438	399	473	451	440	262	383	555	386	110
9	242	226	445	404	475	458	446	259	392	569	392	114
10	250	238	461	416	484	478	461	266	409	591	405	117
11	282	272	534	477	553	550	526	293	474	689	465	139
12	303	289	559	493	567	580	553	315	486	696	484	138
13	298	273	531	472	549	555	532	311	460	659	464	129
14	283	254	501	449	530	519	507	300	431	621	440	122
15	268	237	465	419	492	485	477	283	402	574	410	112
16	254	226	452	409	485	470	460	269	394	568	399	113
17	256	233	464	419	493	481	469	270	409	592	409	118
18	266	245	477	432	502	500	485	280	422	607	422	120
19	273	252	502	453	535	515	503	288	443	647	441	130
20	273	252	498	451	532	514	501	290	439	641	439	128
21	271	252	499	452	536	513	501	291	438	639	439	128
22	271	253	500	451	535	513	499	293	436	633	438	127
23	273	254	499	450	533	512	500	295	434	633	438	125
24	276	257	504	451	535	516	505	297	435	635	441	126
25	278	255	502	452	533	520	506	299	435	631	441	125
26	275	250	493	442	528	506	498	295	423	616	433	122
27	264	240	478	430	515	484	479	284	412	602	419	119
28	255	230	463	422	507	473	468	273	406	599	410	120
29	250	229	462	421	506	473	463	268	407	602	408	122
30	254	234	468	428	513	484	472	272	419	618	416	125
31	260	243	481	438	521	492	481	280	427	628	425	126
32	255	238	474	430	517	482	472	277	419	619	418	125
33	254	242	478	433	516	484	473	278	421	617	420	124
34	262	253	492	443	522	500	487	288	429	624	430	124
35	272	257	494	443	517	509	493	295	427	616	432	120
36	267	248	482	435	513	496	485	291	418	601	423	118
37	266	245	479	432	512	492	482	287	416	601	421	118
38	266	243	481	436	519	492	485	285	420	613	424	122
39	266	244	488	440	525	497	488	284	427	623	428	125

(Sheet 1 of 6)

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
40	263	242	483	438	523	493	485	282	425	621	425	125
41	261	243	484	440	525	493	484	283	426	623	426	125
42	260	246	482	438	524	490	481	285	422	617	425	123
43	253	242	472	428	512	475	468	283	408	601	414	119
44	245	239	464	421	508	461	455	280	399	588	406	117
45	246	241	471	425	520	463	459	282	402	600	411	120
46	236	230	442	398	474	442	435	270	375	547	385	107
47	243	237	455	408	481	460	448	271	391	566	396	111
48	252	247	470	419	489	477	463	279	403	582	408	113
49	259	253	483	432	508	494	477	289	415	601	421	118
50	263	253	493	442	524	501	487	291	425	619	430	123
51	272	260	508	456	540	517	504	298	440	644	444	128
52	278	264	512	459	541	524	509	302	441	642	447	127
53	277	262	509	458	545	520	507	305	437	641	446	126
54	274	257	502	454	541	513	503	301	433	636	441	126
55	272	253	498	448	536	507	498	296	430	633	437	126
56	269	252	491	442	526	498	493	294	423	618	431	122
57	264	248	487	438	526	489	484	291	420	614	426	121
58	266	249	490	443	532	496	489	290	426	628	431	125
59	269	252	499	450	537	504	494	292	433	634	436	126
60	272	255	503	453	538	511	501	296	437	637	440	127
61	279	261	508	458	542	518	509	304	440	640	446	126
62	275	255	502	454	542	507	502	302	431	630	440	124
63	271	251	497	452	546	499	496	298	429	633	437	126
64	268	248	498	450	545	496	493	293	429	635	436	127
65	273	254	508	457	554	506	503	296	440	651	444	131
66	277	256	511	457	552	511	506	298	442	652	446	130
67	274	255	502	451	539	505	500	297	432	632	439	125
68	269	249	495	445	538	497	492	294	426	626	433	125
69	268	247	493	445	538	494	490	292	425	626	432	125
70	268	247	495	447	542	495	492	292	428	632	434	127
71	273	252	506	455	554	506	502	294	441	651	444	131
72	278	255	511	459	554	515	509	295	446	657	448	132
73	279	255	506	455	543	514	508	297	441	645	444	128
74	274	248	495	447	536	504	500	294	432	631	436	126
75	270	245	488	440	529	492	490	291	421	616	428	122
76	265	240	485	438	532	484	483	287	418	620	425	124
77	262	240	482	439	534	483	482	286	421	624	425	125
78	268	247	495	449	546	495	493	292	433	643	436	129
79	273	252	502	457	552	505	503	297	440	650	443	130

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
80	275	252	501	455	548	504	501	300	436	639	441	127
81	271	249	493	447	539	492	493	299	423	622	433	123
82	262	240	476	433	527	473	476	294	407	601	419	119
83	254	232	465	424	521	457	462	283	399	595	409	119
84	251	229	461	425	517	455	460	277	404	601	408	121
85	263	241	486	443	540	484	482	284	429	636	429	128
86	275	252	502	457	551	506	504	295	443	653	444	131
87	273	247	500	451	547	500	498	292	436	642	439	129
88	266	243	488	439	532	487	485	287	423	622	427	125
89	265	241	484	436	527	484	482	285	420	616	424	123
90	265	243	485	437	528	485	484	288	419	615	425	122
91	265	242	483	438	528	483	484	288	419	613	424	122
92	267	242	482	439	529	485	485	290	419	615	425	122
93	265	241	481	438	528	482	483	289	416	616	424	123
94	266	241	483	439	530	484	485	290	419	619	426	123
95	266	240	483	438	531	485	484	290	416	615	425	123
96	264	236	479	435	530	478	479	289	411	610	421	122
97	247	222	443	403	490	441	443	279	374	549	389	108
98	245	221	447	407	499	444	446	276	382	568	394	113
99	249	225	453	414	504	454	454	277	391	579	400	115
100	249	226	450	413	499	453	454	277	391	576	399	114
101	249	226	450	411	497	453	452	276	391	575	398	114
102	250	225	448	409	493	453	452	276	389	569	396	112
103	250	225	448	410	495	454	453	276	390	571	397	113
104	249	224	447	411	497	451	452	276	390	572	397	113
105	247	224	446	410	498	447	449	275	393	576	397	114
106	250	227	453	415	502	454	456	277	396	583	401	116
107	251	230	454	415	500	453	455	280	395	575	401	113
108	250	226	448	411	497	452	452	278	388	572	397	113
109	246	224	441	405	489	442	444	276	382	558	391	109
110	244	222	444	405	495	439	442	275	380	563	391	112
111	245	222	443	407	497	440	445	274	385	572	393	113
112	247	223	447	411	503	447	449	275	389	582	397	116
113	249	228	456	418	511	455	456	278	397	591	404	118
114	255	231	463	424	518	463	464	284	402	597	410	119
115	256	231	464	424	517	464	466	285	399	594	410	118
116	252	226	455	417	508	451	456	282	391	577	401	115
117	248	219	448	410	503	445	448	276	384	572	396	115
118	247	217	444	409	499	444	445	274	383	572	393	114
119	246	217	442	406	496	443	446	270	387	572	393	115

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
120	246	217	441	406	493	442	446	269	387	572	392	114
121	243	215	436	400	487	435	440	266	382	564	387	112
122	239	213	428	396	479	428	434	263	378	555	381	111
123	242	216	432	401	483	439	439	264	384	566	387	113
124	245	218	436	403	487	444	443	269	386	566	390	112
125	243	219	435	401	485	437	441	269	381	559	387	111
126	240	217	433	400	486	432	437	269	378	558	385	111
127	229	209	411	380	461	409	414	266	351	517	365	101
128	229	209	413	382	466	409	415	265	353	521	366	102
129	226	206	408	378	461	404	410	260	352	521	362	103
130	228	209	414	384	467	411	416	258	363	535	369	106
131	236	215	427	394	478	432	431	263	376	555	381	110
132	240	218	430	397	479	436	435	267	378	554	384	109
133	236	215	425	392	473	424	429	264	370	543	377	107
134	234	215	424	391	473	423	427	264	371	546	377	108
135	238	217	429	396	479	429	433	267	375	550	381	108
136	237	217	429	396	479	429	432	266	376	551	381	109
137	236	216	428	393	475	427	429	264	373	548	379	108
138	236	215	424	390	469	425	428	262	371	540	376	106
139	238	218	427	392	469	427	430	266	372	538	378	105
140	239	217	425	392	469	428	430	266	371	540	378	105
141	237	214	423	391	470	423	427	267	367	533	375	104
142	236	212	421	390	473	421	427	266	365	536	375	106
143	236	214	422	391	476	421	426	266	368	541	376	107
144	235	213	423	390	474	419	426	264	369	542	376	107
145	233	212	421	389	473	418	424	262	369	542	374	107
146	233	214	423	391	474	417	425	263	368	541	375	107
147	233	214	423	390	473	416	424	262	369	542	375	107
148	235	216	427	394	478	421	429	266	373	545	378	108
149	235	215	422	394	476	417	425	269	369	539	376	106
150	233	212	420	394	476	409	422	267	368	537	374	106
151	234	215	424	395	478	412	424	267	371	544	376	107
152	235	217	425	394	478	413	425	268	372	542	377	106
153	231	211	415	386	470	404	416	265	362	529	369	104
154	224	208	407	378	460	391	406	261	353	515	360	101
155	221	206	403	375	456	385	401	260	349	506	356	99
156	220	206	402	375	456	385	399	259	347	506	356	99
157	219	206	402	374	455	383	397	258	346	505	355	99
158	219	204	402	374	455	384	399	255	350	512	355	101
159	225	207	411	381	463	397	409	258	358	525	363	104



Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
160	229	210	415	384	467	404	413	261	363	529	367	104
161	227	208	413	381	464	401	411	258	361	527	365	104
162	225	206	407	379	459	397	408	256	359	524	362	103
163	228	210	413	382	461	401	412	259	364	528	366	103
164	229	211	414	383	461	405	413	259	365	526	366	103
165	227	207	409	378	458	401	409	256	359	520	362	102
166	225	206	405	374	452	397	405	254	355	513	359	100
167	226	206	408	376	454	400	408	254	358	516	361	102
168	229	209	417	382	462	406	414	258	363	527	367	104
169	232	212	421	387	467	413	420	258	370	536	372	106
170	235	213	423	392	471	420	426	259	376	547	376	108
171	240	219	433	398	478	429	435	264	384	557	384	110
172	243	221	437	402	482	435	440	266	387	560	387	110
173	244	222	439	403	485	436	442	268	387	561	389	111
174	245	221	438	402	484	437	441	268	385	559	388	110
175	244	221	435	400	481	436	440	268	381	557	386	109
176	246	219	435	401	479	435	439	268	381	550	385	108
177	247	220	437	404	482	438	443	270	383	552	388	108
178	247	221	437	405	486	439	445	270	386	558	390	110
179	249	223	441	408	487	441	449	272	389	561	392	110
180	251	224	441	408	487	442	450	274	388	559	392	109
181	250	223	441	408	488	441	449	275	386	558	392	109
182	253	223	440	410	488	444	452	279	386	557	393	108
183	252	223	438	405	485	438	446	280	380	550	390	106
184	247	217	428	399	479	426	439	277	371	536	382	104
185	240	211	419	392	471	415	427	271	362	524	373	102
186	237	207	414	386	467	408	422	267	358	519	368	102
187	229	201	395	364	435	394	402	258	338	484	350	93
188	229	200	390	363	430	395	402	257	340	485	349	92
189	229	201	391	365	434	393	404	259	341	486	350	93
190	231	203	399	373	447	399	409	262	345	498	357	96
191	232	204	400	375	450	397	409	264	348	500	358	96
192	231	204	400	375	449	394	407	262	348	498	357	96
193	236	209	411	386	459	397	418	268	360	507	365	98
194	236	208	410	383	457	393	415	270	353	501	363	96
195	231	205	399	374	446	381	405	266	345	484	354	92
196	226	200	392	366	436	371	394	261	335	470	345	89
197	221	196	382	356	425	360	384	257	326	456	336	86
198	217	196	380	355	421	350	379	255	323	449	332	85
199	212	192	370	346	411	338	368	251	314	435	324	82

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
200	208	191	367	342	407	330	361	250	309	429	319	80
201	207	192	367	343	408	329	361	249	309	427	319	80
202	208	191	365	341	408	331	362	249	308	430	319	81
203	204	188	361	335	402	326	355	245	303	421	314	79
204	200	186	354	330	395	321	349	242	296	413	309	77
205	200	185	354	329	394	319	348	240	295	412	308	77
206	199	187	355	327	392	319	347	239	296	413	307	77
207	198	187	352	326	389	320	346	238	298	415	307	77
208	197	184	350	323	387	320	345	236	297	413	305	77
209	197	185	351	324	387	321	346	238	296	413	306	77
210	202	190	359	333	398	328	354	243	304	424	313	79
211	200	187	357	326	393	324	349	241	296	414	309	78
212	190	179	341	315	380	307	334	232	282	396	296	75
213	188	178	337	313	376	306	331	230	281	395	294	74
214	191	181	341	320	383	314	337	235	287	407	300	76
215	198	186	353	330	395	327	349	241	300	423	310	80
216	203	191	361	337	403	336	358	246	306	431	317	81
217	205	193	364	339	405	337	359	250	303	428	318	80
218	203	189	360	335	398	330	354	249	297	419	313	78
219	201	188	356	330	393	326	349	246	293	411	309	76
220	200	186	352	329	391	324	348	245	292	410	308	76
221	201	186	352	328	389	326	349	244	293	411	308	76
222	201	187	351	326	383	324	345	246	290	397	305	73
223	195	185	344	319	374	313	336	245	277	379	297	69
224	187	181	331	307	358	297	319	240	263	355	284	64
225	179	177	323	299	349	284	307	235	253	342	275	62
226	175	173	316	292	342	277	301	229	251	340	270	62
227	175	172	314	291	341	277	300	230	249	337	269	61
228	173	172	309	289	335	274	297	229	247	330	265	59
229	170	171	304	286	330	269	291	228	242	324	261	58
230	166	170	301	284	326	266	287	227	239	319	259	57
231	163	169	296	282	323	262	283	226	237	316	256	56
232	161	167	294	280	320	259	280	225	234	312	253	56
233	160	167	291	280	320	258	279	225	234	314	253	56
234	162	171	296	284	325	262	284	230	237	320	257	57
235	169	179	309	296	337	272	293	241	246	330	267	58
236	174	190	322	307	349	280	300	255	251	337	276	59

(Sheet 6 of 6)

## **Appendix C: Average Annual Longshore Transport Rates for Plan 1 with Borrow Area<sup>1</sup>**

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<sup>1</sup> This appendix contains figures and tables for south, north, net, and gross longshore transport rates.

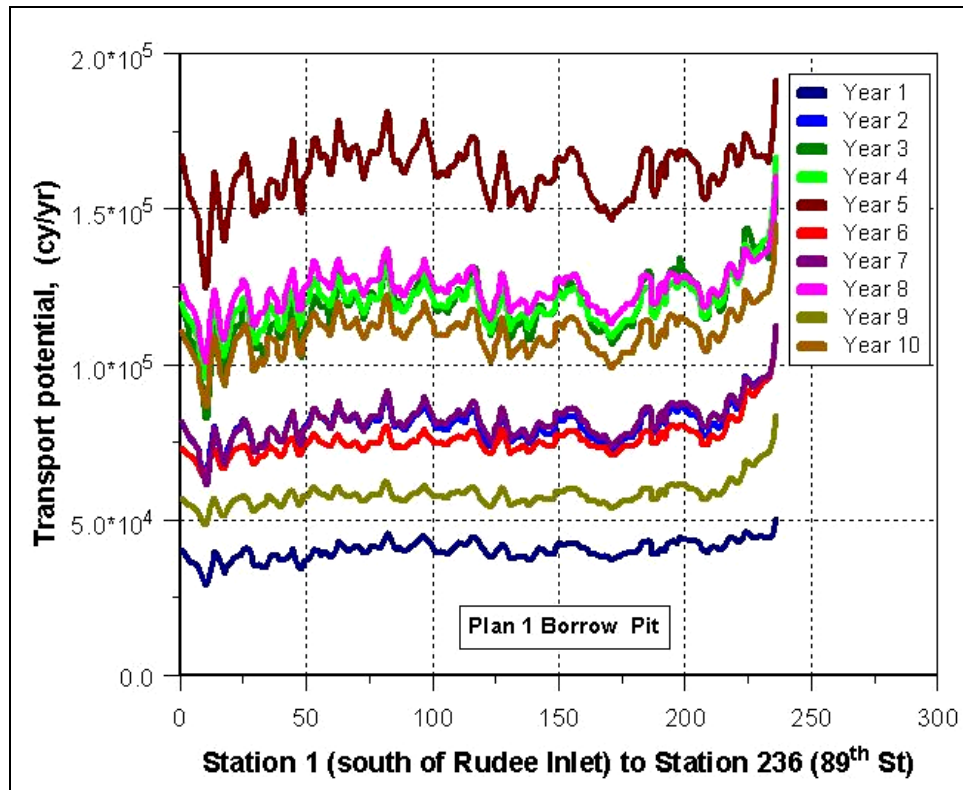


Figure C1. Average annual south longshore transport rates for monitoring stations, Plan 1 with borrow area.

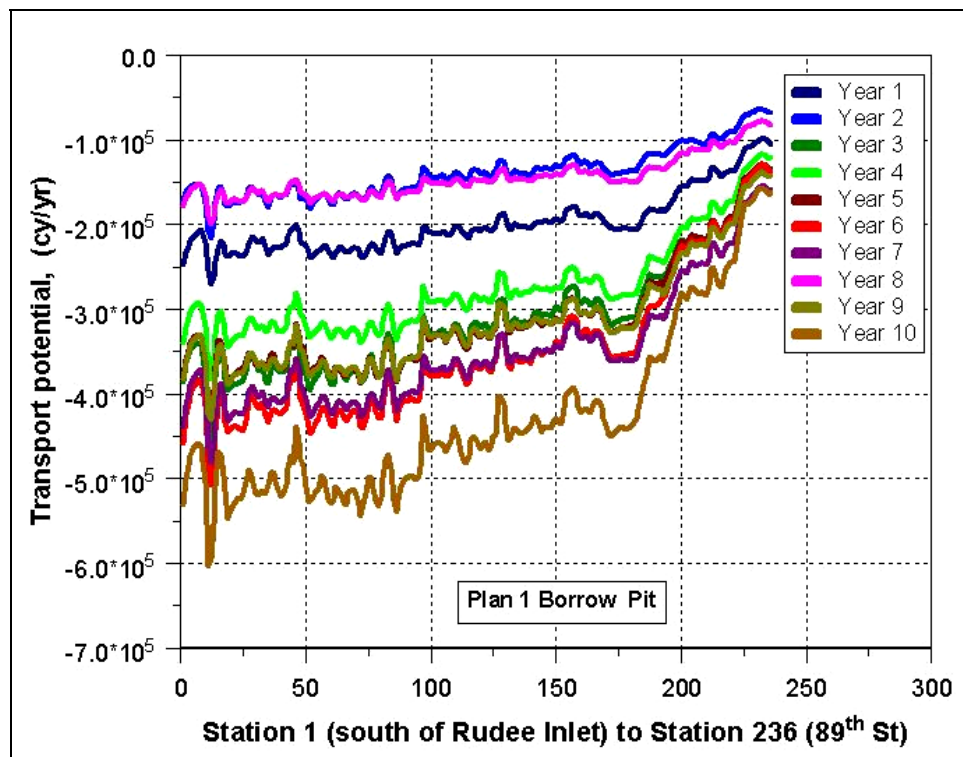


Figure C2. Average annual north longshore transport rates for monitoring stations, Plan 1 with borrow area.

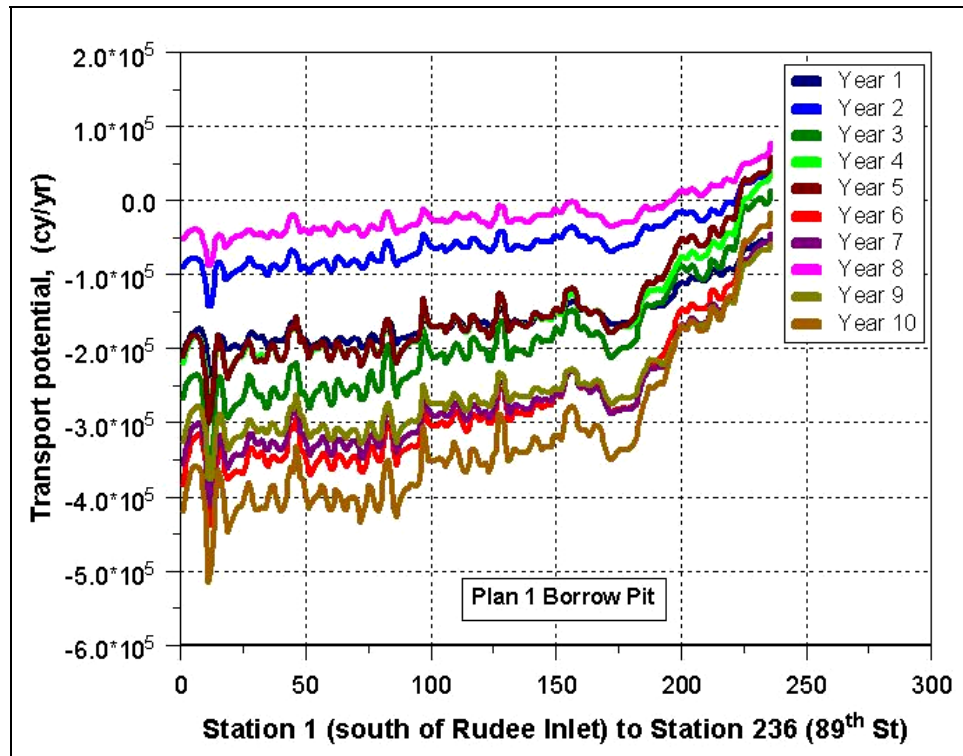


Figure C3. Average annual net longshore transport rates for monitoring stations, Plan 1 with borrow area.

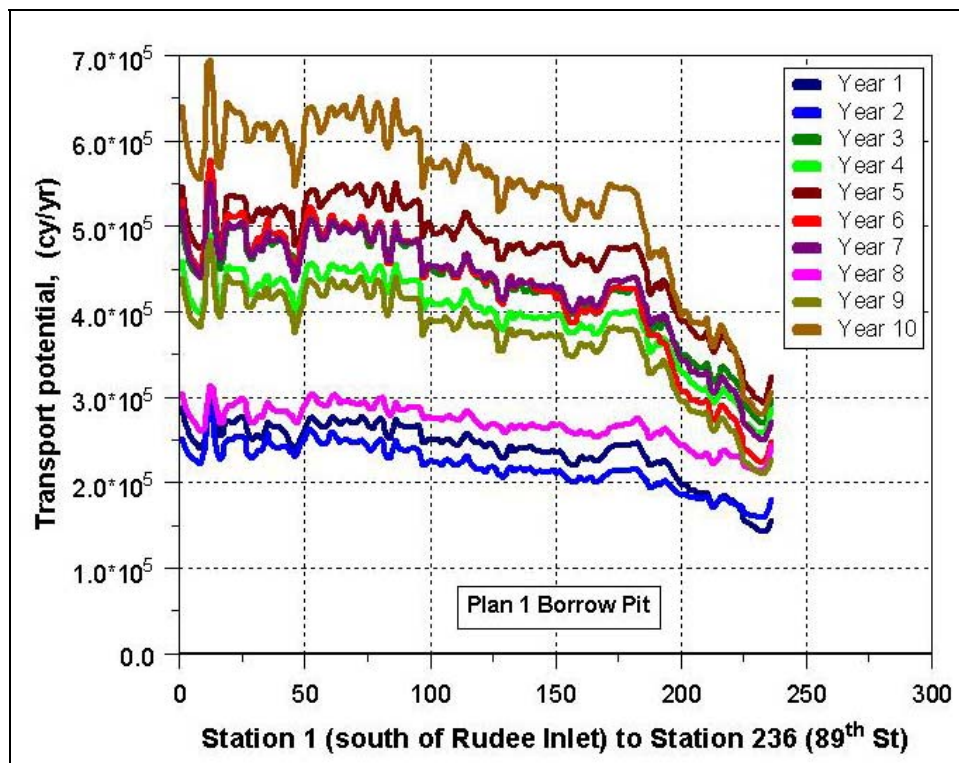


Figure C4. Average annual gross longshore transport rates for monitoring stations, Plan 1 with borrow area.

Table C1. Southern longshore transport rates, Plan 1, 1990–1999, 1,000 cu yd/yr.

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
1	41	81	119	120	167	73	82	125	57	111	98	38
2	39	79	116	117	161	72	79	122	56	108	95	36
3	37	77	112	115	158	71	77	120	55	106	93	36
4	37	77	108	114	154	70	76	119	55	105	92	35
5	36	76	107	113	153	70	76	118	54	104	91	35
6	36	74	105	110	150	69	74	116	54	101	89	34
7	35	73	105	108	147	68	73	113	53	100	87	33
8	33	69	97	104	140	66	69	109	51	94	83	31
9	31	66	90	99	131	64	65	104	49	90	79	29
10	29	63	83	96	124	63	62	101	48	86	76	28
11	29	64	83	97	126	64	61	103	49	87	76	28
12	33	73	96	109	143	70	69	114	54	100	86	32
13	37	78	108	116	155	72	76	121	57	106	93	35
14	40	80	117	118	162	73	80	124	57	109	96	37
15	38	77	112	113	156	70	77	119	55	105	92	35
16	36	71	105	107	147	67	72	111	52	97	87	33
17	34	69	98	103	140	67	69	108	51	95	83	31
18	33	69	95	104	140	67	68	109	51	93	83	31
19	36	73	103	108	147	69	71	114	53	99	87	33
20	36	75	106	112	153	71	75	118	55	102	90	34
21	37	77	110	114	157	72	76	120	56	104	92	35
22	38	79	112	117	160	73	78	122	57	108	94	36
23	38	80	112	118	162	73	79	124	57	109	95	36
24	39	80	113	118	162	73	79	124	57	110	95	36
25	40	82	118	121	166	74	82	127	58	112	98	37
26	41	82	120	121	168	74	82	126	58	113	98	38
27	41	79	119	117	164	72	80	122	56	109	96	37
28	39	76	113	111	156	69	76	116	54	103	91	35
29	36	72	106	108	149	68	72	113	52	98	87	33
30	35	72	105	107	148	68	72	112	53	98	87	33
31	35	74	107	110	152	70	74	116	54	101	89	34
32	36	74	107	111	153	71	74	117	55	102	90	34
33	35	74	103	111	149	70	73	116	54	100	89	34
34	34	76	104	114	151	72	74	119	56	102	90	34
35	36	78	109	119	157	74	78	123	58	109	94	36
36	38	80	112	119	160	74	80	124	57	108	95	36
37	39	79	113	117	159	73	79	122	56	108	94	36
38	39	78	113	115	159	72	78	121	56	107	94	36
39	38	76	110	112	154	71	75	117	55	103	91	34

(Sheet 1 of 6)

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
40	37	75	109	111	153	70	75	117	54	101	90	34
41	37	76	109	113	155	71	76	119	55	102	91	35
42	38	79	111	117	160	73	78	123	57	106	94	36
43	38	82	114	120	164	75	81	126	58	111	97	37
44	40	83	119	123	169	76	83	129	59	114	100	38
45	41	84	122	124	172	76	85	131	59	115	101	39
46	37	79	112	119	160	74	79	124	57	108	95	36
47	35	75	105	113	151	71	75	117	55	103	90	34
48	34	75	102	113	149	71	74	118	55	103	90	34
49	36	79	110	120	160	74	79	124	58	108	95	36
50	37	80	112	120	161	74	80	125	57	110	96	37
51	38	81	114	121	163	75	80	126	58	111	97	37
52	38	83	115	124	166	76	82	129	59	114	99	38
53	40	86	121	128	173	78	86	133	61	117	102	39
54	40	85	122	127	173	77	85	132	60	116	102	39
55	40	83	119	122	168	75	83	128	58	113	99	38
56	39	83	118	123	166	75	82	127	59	113	99	38
57	40	82	119	122	168	75	83	127	58	113	99	38
58	39	82	118	121	167	74	82	126	58	112	98	38
59	38	80	113	119	161	74	79	124	57	109	95	36
60	38	80	113	119	161	74	79	125	57	110	96	37
61	39	84	118	124	167	76	83	130	59	115	99	38
62	41	86	124	128	175	77	87	133	60	120	103	40
63	43	88	130	129	179	77	88	134	61	120	105	41
64	42	84	124	124	173	75	85	130	59	116	101	39
65	41	83	122	122	170	74	83	129	58	113	100	39
66	40	81	120	120	167	73	82	127	57	112	98	38
67	40	81	119	120	166	74	82	127	57	112	98	38
68	41	82	121	123	170	74	84	128	58	113	99	38
69	41	83	122	123	170	75	84	129	58	113	100	38
70	42	83	123	123	170	75	84	129	58	115	100	39
71	41	81	120	119	167	73	82	126	57	111	98	38
72	40	80	116	117	162	73	79	123	56	109	96	36
73	39	79	114	116	160	72	78	122	56	108	95	36
74	40	80	117	118	164	73	81	125	57	110	96	37
75	41	82	121	122	167	75	83	127	58	113	99	38
76	42	83	123	122	169	75	84	127	58	113	99	38
77	41	82	122	122	168	75	83	127	58	113	99	38
78	41	82	121	121	168	75	83	127	58	112	99	38
79	41	82	121	122	170	75	83	128	58	113	99	38

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
80	42	84	124	126	172	77	86	131	59	116	102	39
81	44	88	130	130	178	80	89	136	62	121	106	40
82	45	90	135	132	182	80	92	138	62	123	108	41
83	46	88	134	129	180	78	90	134	61	120	106	41
84	43	83	125	121	169	74	84	127	58	113	100	38
85	41	80	120	118	165	73	81	123	57	110	97	37
86	40	81	120	119	166	74	81	125	57	111	97	37
87	41	81	121	120	165	74	82	125	57	111	98	37
88	40	79	118	117	162	73	80	122	56	109	96	36
89	40	79	118	117	162	73	80	122	56	108	96	36
90	40	80	118	118	163	74	81	124	57	110	97	37
91	41	81	120	120	166	75	82	126	58	111	98	37
92	42	83	123	123	168	76	84	128	59	114	100	38
93	42	84	124	123	169	76	85	128	59	114	100	38
94	43	83	125	123	170	75	84	128	59	115	100	38
95	44	84	128	125	173	77	86	130	60	116	102	39
96	45	85	131	126	175	78	88	132	60	117	104	39
97	44	88	134	130	179	80	90	134	61	120	106	40
98	44	85	130	125	173	77	87	130	60	117	103	39
99	43	83	126	123	170	77	85	128	59	115	101	38
100	41	82	121	121	165	75	83	126	58	113	99	37
101	40	80	118	119	162	74	81	124	57	110	97	36
102	39	79	117	119	160	74	81	123	57	109	96	36
103	40	80	118	119	162	75	82	124	58	110	97	36
104	40	80	119	119	162	75	82	125	58	110	97	36
105	39	79	118	118	162	74	81	123	57	109	96	36
106	39	79	116	119	161	74	81	123	57	110	96	36
107	39	81	118	121	164	76	82	126	58	112	98	37
108	40	81	119	121	163	76	83	126	58	112	98	37
109	41	82	121	122	165	77	84	127	59	113	99	37
110	43	83	124	124	168	77	85	129	59	114	101	38
111	43	82	124	123	168	77	84	127	59	113	100	38
112	42	82	123	121	166	76	83	126	58	112	99	37
113	42	81	122	121	167	76	84	127	59	112	99	37
114	42	84	125	124	170	77	85	130	60	114	101	38
115	43	85	128	126	173	78	87	131	60	117	103	39
116	44	86	131	127	174	79	88	131	61	118	104	39
117	44	84	131	125	172	78	87	129	60	116	103	39
118	43	82	127	123	167	77	84	127	59	114	100	38
119	42	78	121	117	160	74	81	122	56	108	96	36



Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
120	41	78	120	116	158	74	80	120	56	107	95	35
121	40	76	117	114	156	72	78	118	55	105	93	35
122	39	74	114	112	153	72	77	116	55	103	91	34
123	38	73	109	110	150	71	75	115	54	101	90	33
124	38	75	112	113	153	73	77	118	55	103	92	34
125	39	78	116	116	157	74	80	121	57	106	94	35
126	40	79	119	118	161	75	81	123	58	109	96	36
127	42	83	125	125	168	79	86	129	60	115	101	38
128	42	84	126	125	168	79	86	129	60	115	101	38
129	42	81	121	120	162	76	83	125	58	110	98	36
130	39	77	116	115	157	73	79	119	56	105	94	35
131	37	75	108	111	151	71	76	117	55	102	90	34
132	37	76	110	114	153	72	77	119	55	103	91	34
133	38	76	113	115	155	72	78	119	55	105	93	35
134	38	77	113	115	156	73	78	119	56	105	93	35
135	38	77	114	116	157	73	79	121	56	107	94	35
136	38	77	114	116	156	74	79	121	56	107	94	35
137	38	76	111	114	152	73	77	119	56	104	92	34
138	37	75	108	112	149	72	76	117	55	102	90	33
139	37	75	108	113	150	72	76	118	55	103	91	34
140	38	77	111	116	153	74	78	120	56	106	93	34
141	39	78	116	117	158	75	80	122	57	107	95	35
142	41	79	119	118	160	75	81	123	58	108	96	36
143	41	79	119	118	161	75	81	123	57	109	96	36
144	40	78	117	117	159	75	80	122	57	107	95	35
145	39	77	116	116	158	74	80	121	57	106	95	35
146	39	78	116	116	158	74	80	121	57	106	94	35
147	39	78	116	116	159	74	80	121	57	107	95	36
148	39	79	117	117	160	74	81	122	57	108	95	36
149	41	82	121	122	165	78	84	127	59	113	99	37
150	43	83	124	123	167	77	85	128	59	113	100	37
151	42	82	123	122	166	77	84	127	59	113	99	37
152	42	82	122	121	165	77	84	126	59	112	99	37
153	42	83	123	124	167	78	85	128	60	115	101	37
154	42	83	126	124	169	78	86	128	60	115	101	38
155	42	83	126	124	170	78	86	128	60	116	101	38
156	42	83	124	125	168	79	86	129	60	114	101	38
157	43	83	125	124	168	78	86	129	60	114	101	38
158	42	81	123	122	165	77	84	126	59	112	99	37
159	41	79	120	119	161	75	82	123	58	110	97	36

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
160	41	79	120	120	161	76	82	123	58	110	97	36
161	41	78	119	118	159	75	81	123	57	109	96	36
162	40	77	115	115	156	74	79	119	56	106	94	35
163	39	76	112	115	154	73	78	119	56	105	93	34
164	39	76	112	115	153	74	78	119	56	105	93	34
165	39	76	111	114	151	73	77	118	56	105	92	34
166	38	75	110	113	150	73	76	117	55	103	91	33
167	38	75	110	113	149	73	77	117	55	103	91	33
168	38	75	112	113	151	73	77	118	56	103	92	34
169	39	75	112	112	150	73	76	116	55	102	91	33
170	38	73	109	109	148	71	75	113	54	100	89	33
171	37	72	107	109	147	71	74	113	54	99	88	32
172	37	73	107	110	149	71	75	115	54	100	89	33
173	38	74	108	110	149	72	75	115	54	101	90	33
174	38	75	110	112	150	72	76	116	55	101	90	33
175	39	76	112	114	151	74	77	118	56	104	92	34
176	39	76	112	114	151	74	77	118	56	104	92	33
177	40	77	113	114	153	74	78	120	56	104	93	34
178	39	77	112	114	153	73	78	119	56	104	93	34
179	39	76	112	114	152	73	78	119	56	103	92	34
180	39	78	115	115	156	74	79	121	57	106	94	35
181	40	79	117	118	159	75	81	122	57	107	95	36
182	41	80	119	119	163	75	82	124	58	109	97	36
183	43	84	126	123	167	78	85	128	60	113	101	37
184	43	84	128	125	169	78	86	129	60	114	102	38
185	43	85	130	125	170	79	87	129	60	114	102	38
186	43	85	130	124	168	78	86	128	60	114	102	38
187	39	79	118	117	157	74	80	120	57	107	95	35
188	39	78	116	115	154	75	79	120	56	105	94	34
189	39	79	118	117	157	75	81	121	57	107	95	35
190	41	82	124	121	163	77	84	125	59	110	99	36
191	41	83	125	123	165	78	85	126	60	111	100	37
192	40	81	121	119	160	76	82	123	58	109	97	36
193	42	84	126	124	167	79	86	127	60	114	101	37
194	43	85	130	126	169	80	87	129	61	116	103	38
195	43	86	131	126	168	80	87	129	61	116	103	38
196	43	86	131	126	168	80	87	129	61	115	103	38
197	42	85	129	125	166	79	86	126	61	112	101	37
198	44	87	134	126	169	81	88	128	61	115	103	38
199	44	86	131	126	167	80	87	128	61	115	102	37

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
200	44	86	130	127	169	80	88	129	62	114	103	37
201	44	85	129	126	168	79	87	128	61	114	102	38
202	43	84	128	124	167	79	86	127	60	113	101	37
203	43	84	127	124	166	79	86	126	60	113	101	37
204	43	84	126	124	166	78	86	126	60	113	101	37
205	43	83	126	123	164	78	85	125	59	111	100	36
206	42	81	121	119	158	76	82	123	58	109	97	35
207	40	77	116	116	155	74	80	119	56	106	94	34
208	40	77	115	115	153	74	80	118	56	104	93	34
209	40	78	115	116	154	74	80	119	57	105	94	34
210	41	80	119	119	159	76	82	123	58	109	97	35
211	42	81	121	122	161	77	84	125	59	110	98	36
212	42	81	122	121	160	77	84	123	59	109	98	36
213	41	79	118	119	158	76	83	122	58	108	96	35
214	40	80	117	119	159	77	82	123	58	108	96	35
215	41	81	118	120	160	77	83	124	59	109	97	35
216	42	83	122	125	165	79	86	128	61	113	100	37
217	43	86	128	128	169	81	89	131	62	116	103	38
218	45	88	132	130	170	84	90	133	64	118	105	38
219	44	88	132	130	170	83	90	132	63	117	105	38
220	44	86	129	127	166	82	88	129	62	115	103	37
221	42	85	128	126	164	81	87	128	62	114	102	36
222	43	87	129	128	166	83	89	129	63	115	103	37
223	45	92	138	134	171	87	93	134	66	119	108	38
224	46	96	144	139	175	92	96	137	69	124	112	39
225	46	96	144	137	173	92	95	136	69	123	111	38
226	45	94	141	136	171	90	94	134	68	121	109	38
227	44	93	137	135	168	90	93	133	68	120	108	37
228	44	93	137	136	167	91	93	133	68	120	108	37
229	45	94	138	137	167	92	94	134	69	121	109	37
230	45	96	138	138	167	94	96	135	70	122	110	37
231	44	95	138	140	167	94	96	135	71	123	110	37
232	44	95	137	140	167	95	96	136	71	123	110	37
233	44	95	134	141	165	96	96	137	72	124	110	36
234	44	97	134	143	168	97	97	140	73	126	112	37
235	46	101	140	150	176	101	102	146	76	132	117	39
236	50	112	156	167	192	112	113	161	84	145	129	43

Table C2. Northern longshore transport rates, Plan 1, 1990–1999, 1,000 cu yd/yr.

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
1	-247	-171	-386	-340	-379	-458	-438	-178	-383	-530	-351	119
2	-233	-162	-364	-321	-360	-426	-414	-169	-364	-501	-331	112
3	-225	-158	-355	-310	-347	-413	-399	-163	-351	-485	-321	108
4	-220	-156	-349	-303	-340	-401	-389	-160	-344	-474	-314	105
5	-215	-154	-344	-297	-334	-392	-382	-157	-337	-464	-307	103
6	-213	-153	-340	-295	-332	-389	-378	-155	-334	-461	-305	102
7	-208	-152	-340	-292	-331	-383	-372	-152	-330	-459	-302	102
8	-207	-153	-342	-295	-333	-385	-372	-153	-332	-461	-303	102
9	-211	-160	-354	-304	-343	-393	-381	-156	-342	-480	-312	106
10	-221	-175	-377	-320	-359	-414	-399	-165	-360	-504	-329	110
11	-253	-207	-450	-379	-428	-484	-463	-190	-424	-603	-388	132
12	-269	-215	-461	-382	-424	-508	-481	-200	-430	-595	-397	130
13	-261	-195	-425	-355	-395	-483	-456	-191	-402	-553	-372	122
14	-243	-173	-381	-330	-367	-443	-427	-176	-373	-510	-342	113
15	-229	-159	-350	-306	-336	-415	-400	-166	-346	-467	-317	104
16	-218	-155	-345	-302	-338	-401	-388	-159	-341	-472	-312	105
17	-222	-163	-363	-315	-354	-414	-401	-163	-355	-496	-324	110
18	-233	-176	-383	-329	-365	-433	-418	-172	-371	-514	-339	113
19	-238	-177	-396	-345	-388	-445	-432	-174	-389	-547	-353	122
20	-235	-176	-392	-340	-382	-443	-427	-173	-383	-538	-349	120
21	-233	-173	-389	-335	-379	-439	-421	-170	-378	-531	-345	118
22	-234	-174	-388	-333	-375	-438	-421	-171	-377	-526	-344	117
23	-234	-175	-387	-331	-372	-438	-422	-171	-376	-523	-343	116
24	-237	-174	-386	-332	-372	-441	-423	-173	-376	-524	-344	116
25	-238	-173	-384	-331	-370	-443	-424	-173	-374	-518	-343	115
26	-234	-168	-374	-321	-361	-432	-415	-169	-365	-505	-334	112
27	-223	-157	-353	-312	-352	-408	-398	-161	-352	-490	-321	109
28	-216	-155	-352	-310	-353	-403	-392	-157	-350	-496	-318	111
29	-214	-157	-355	-313	-357	-403	-391	-157	-355	-505	-321	113
30	-218	-161	-365	-320	-366	-413	-398	-160	-362	-517	-328	116
31	-222	-165	-372	-323	-368	-417	-403	-163	-367	-519	-332	116
32	-219	-163	-368	-319	-367	-410	-398	-161	-363	-517	-328	115
33	-217	-164	-369	-319	-364	-411	-397	-161	-362	-514	-328	114
34	-226	-173	-384	-326	-369	-426	-410	-167	-370	-518	-337	115
35	-236	-179	-387	-324	-362	-434	-416	-172	-370	-507	-339	111
36	-229	-169	-370	-315	-353	-421	-406	-167	-359	-493	-328	109
37	-228	-166	-365	-314	-353	-418	-404	-165	-358	-492	-326	109
38	-226	-164	-368	-318	-360	-418	-406	-164	-362	-503	-329	112
39	-227	-165	-373	-326	-368	-422	-410	-166	-368	-513	-334	115

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
40	-227	-168	-375	-327	-370	-423	-411	-166	-371	-520	-336	116
41	-224	-166	-375	-325	-369	-420	-407	-164	-368	-518	-334	115
42	-222	-165	-369	-320	-362	-415	-402	-163	-362	-507	-329	113
43	-215	-160	-357	-307	-349	-397	-387	-157	-350	-487	-317	108
44	-206	-152	-343	-296	-338	-383	-372	-150	-338	-473	-305	105
45	-205	-153	-346	-299	-345	-385	-372	-150	-341	-481	-308	107
46	-200	-151	-331	-280	-316	-367	-357	-147	-318	-439	-291	96
47	-207	-160	-347	-291	-329	-384	-369	-153	-332	-457	-303	100
48	-218	-169	-364	-304	-340	-405	-388	-161	-346	-477	-317	104
49	-222	-170	-368	-309	-345	-414	-395	-163	-350	-484	-322	107
50	-225	-170	-377	-320	-361	-423	-405	-164	-364	-508	-332	113
51	-233	-177	-393	-332	-375	-439	-420	-169	-377	-526	-344	117
52	-239	-181	-396	-333	-374	-447	-426	-174	-379	-525	-348	116
53	-237	-174	-386	-329	-370	-441	-421	-171	-374	-522	-343	116
54	-233	-171	-380	-326	-368	-433	-416	-169	-371	-515	-338	114
55	-231	-168	-377	-323	-367	-428	-412	-167	-369	-512	-335	114
56	-228	-165	-366	-316	-356	-419	-404	-165	-361	-497	-328	110
57	-225	-163	-365	-317	-359	-415	-402	-163	-360	-500	-327	111
58	-225	-163	-368	-319	-364	-418	-404	-163	-363	-508	-330	113
59	-231	-170	-381	-328	-374	-427	-415	-167	-375	-524	-339	116
60	-236	-176	-390	-335	-378	-437	-424	-172	-381	-529	-346	117
61	-239	-176	-389	-331	-373	-438	-424	-173	-379	-524	-345	116
62	-234	-168	-375	-325	-367	-428	-415	-169	-370	-509	-336	113
63	-228	-163	-371	-323	-369	-420	-410	-165	-368	-514	-333	115
64	-226	-163	-371	-325	-373	-419	-408	-163	-370	-518	-334	116
65	-229	-167	-379	-330	-379	-426	-414	-165	-375	-527	-339	118
66	-233	-169	-384	-332	-380	-432	-418	-168	-378	-530	-342	118
67	-233	-169	-379	-326	-370	-429	-415	-169	-371	-515	-338	114
68	-230	-166	-375	-324	-370	-423	-411	-166	-370	-515	-335	115
69	-228	-164	-372	-322	-369	-419	-408	-164	-367	-513	-333	114
70	-228	-164	-373	-325	-373	-421	-410	-164	-370	-519	-334	116
71	-230	-166	-378	-332	-381	-428	-415	-166	-377	-530	-340	119
72	-237	-171	-385	-339	-387	-439	-426	-170	-385	-543	-348	121
73	-238	-171	-384	-336	-378	-440	-426	-172	-381	-530	-346	118
74	-235	-167	-378	-328	-372	-430	-417	-169	-374	-517	-339	115
75	-228	-159	-358	-316	-357	-414	-404	-164	-359	-498	-326	111
76	-223	-154	-353	-315	-358	-406	-399	-160	-358	-500	-323	112
77	-222	-159	-361	-317	-366	-408	-400	-160	-363	-511	-327	114
78	-227	-162	-373	-326	-377	-420	-409	-164	-373	-525	-335	118
79	-232	-165	-379	-331	-381	-428	-416	-167	-380	-533	-341	119

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
80	-234	-167	-378	-328	-374	-428	-416	-168	-375	-522	-339	116
81	-228	-158	-360	-315	-358	-414	-402	-164	-359	-499	-326	111
82	-217	-146	-339	-301	-345	-392	-384	-154	-342	-477	-310	107
83	-208	-141	-328	-293	-339	-377	-370	-149	-334	-471	-301	106
84	-209	-146	-336	-303	-349	-381	-376	-151	-347	-488	-309	109
85	-223	-161	-368	-324	-374	-412	-403	-161	-371	-525	-332	117
86	-234	-169	-385	-336	-386	-432	-421	-169	-384	-538	-346	120
87	-231	-165	-373	-329	-377	-423	-414	-166	-374	-525	-338	117
88	-226	-160	-364	-321	-367	-412	-405	-163	-364	-509	-329	113
89	-226	-159	-359	-318	-362	-409	-402	-163	-361	-502	-326	111
90	-224	-158	-358	-316	-358	-409	-399	-161	-358	-497	-324	111
91	-225	-158	-359	-317	-359	-409	-400	-161	-359	-500	-325	111
92	-223	-157	-357	-313	-356	-406	-398	-161	-357	-496	-322	110
93	-222	-156	-357	-313	-358	-406	-396	-161	-356	-498	-322	111
94	-223	-156	-358	-315	-360	-408	-398	-161	-358	-501	-324	112
95	-224	-154	-354	-312	-358	-407	-397	-160	-355	-497	-322	111
96	-219	-148	-342	-307	-350	-398	-390	-157	-348	-486	-314	109
97	-203	-132	-307	-272	-309	-360	-354	-144	-310	-425	-282	95
98	-202	-136	-316	-282	-323	-365	-359	-145	-321	-446	-290	100
99	-209	-142	-327	-291	-336	-377	-371	-149	-332	-466	-300	104
100	-210	-144	-330	-292	-335	-379	-372	-150	-333	-465	-301	104
101	-210	-145	-329	-291	-332	-379	-372	-151	-332	-462	-300	103
102	-211	-145	-329	-290	-330	-379	-372	-152	-331	-459	-300	102
103	-211	-143	-327	-290	-330	-378	-372	-152	-331	-459	-299	102
104	-209	-142	-325	-289	-330	-374	-369	-151	-330	-458	-298	102
105	-208	-142	-325	-290	-334	-373	-368	-150	-332	-463	-299	103
106	-211	-147	-337	-295	-340	-379	-373	-153	-339	-468	-304	104
107	-212	-146	-330	-292	-334	-379	-373	-153	-333	-462	-301	102
108	-210	-145	-328	-289	-330	-375	-370	-152	-330	-455	-298	101
109	-205	-140	-318	-282	-320	-365	-359	-148	-319	-439	-289	97
110	-203	-138	-317	-282	-323	-362	-358	-146	-321	-444	-289	99
111	-202	-138	-318	-284	-328	-363	-359	-146	-324	-452	-291	101
112	-205	-141	-326	-290	-336	-372	-367	-148	-332	-468	-299	104
113	-210	-145	-333	-297	-344	-381	-374	-151	-339	-478	-305	107
114	-215	-147	-339	-302	-347	-389	-382	-154	-345	-482	-310	108
115	-215	-147	-338	-299	-343	-386	-381	-154	-340	-474	-308	105
116	-209	-138	-321	-289	-330	-374	-369	-150	-328	-455	-296	102
117	-206	-135	-316	-283	-327	-367	-362	-147	-323	-451	-292	101
118	-204	-135	-315	-284	-328	-366	-362	-147	-323	-454	-292	102
119	-206	-137	-319	-289	-332	-371	-365	-148	-329	-461	-296	103

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
120	-207	-140	-322	-290	-334	-371	-368	-149	-331	-464	-297	104
121	-204	-139	-319	-286	-330	-366	-363	-148	-328	-460	-294	102
122	-203	-138	-316	-286	-328	-362	-361	-146	-327	-456	-292	101
123	-206	-143	-326	-292	-335	-373	-368	-150	-333	-467	-299	104
124	-208	-143	-327	-292	-333	-373	-369	-150	-333	-460	-299	102
125	-205	-141	-319	-286	-325	-364	-363	-149	-324	-450	-293	99
126	-200	-138	-314	-281	-323	-359	-357	-146	-322	-449	-289	100
127	-191	-126	-289	-257	-293	-335	-332	-137	-294	-402	-266	89
128	-189	-125	-288	-258	-295	-333	-330	-136	-294	-405	-265	90
129	-186	-124	-289	-259	-299	-332	-330	-134	-296	-412	-266	92
130	-192	-133	-302	-271	-312	-344	-342	-139	-310	-435	-278	96
131	-202	-142	-322	-286	-328	-366	-361	-147	-325	-455	-293	101
132	-206	-144	-324	-287	-326	-370	-365	-149	-325	-450	-295	100
133	-200	-138	-312	-278	-318	-357	-354	-145	-317	-441	-286	98
134	-200	-137	-312	-278	-319	-355	-352	-144	-316	-442	-286	98
135	-202	-139	-317	-282	-323	-361	-358	-146	-320	-445	-289	99
136	-203	-140	-318	-283	-324	-362	-359	-147	-321	-447	-290	99
137	-202	-139	-314	-281	-321	-361	-357	-146	-320	-445	-288	98
138	-203	-140	-315	-281	-321	-361	-357	-147	-320	-443	-289	98
139	-204	-141	-316	-280	-317	-361	-359	-148	-320	-438	-288	96
140	-205	-141	-317	-279	-317	-364	-358	-149	-319	-438	-289	96
141	-201	-136	-306	-274	-310	-354	-351	-146	-311	-427	-282	94
142	-198	-132	-304	-274	-311	-350	-348	-144	-310	-427	-280	95
143	-197	-134	-303	-275	-315	-350	-348	-143	-312	-436	-281	96
144	-197	-135	-309	-277	-320	-354	-352	-143	-316	-444	-285	99
145	-196	-134	-306	-277	-317	-351	-350	-142	-314	-440	-283	98
146	-196	-134	-307	-275	-316	-350	-348	-142	-314	-440	-282	98
147	-196	-134	-306	-276	-317	-349	-349	-142	-315	-438	-282	97
148	-198	-136	-308	-278	-318	-351	-351	-143	-317	-440	-284	97
149	-197	-133	-304	-275	-315	-347	-347	-142	-313	-433	-281	96
150	-193	-128	-296	-273	-311	-338	-342	-139	-311	-429	-276	95
151	-194	-131	-299	-275	-312	-338	-344	-141	-314	-431	-278	95
152	-196	-132	-302	-275	-315	-343	-346	-142	-314	-435	-280	96
153	-191	-127	-292	-266	-304	-331	-336	-138	-305	-417	-271	92
154	-185	-123	-281	-256	-293	-319	-325	-134	-293	-403	-261	89
155	-182	-121	-276	-253	-290	-312	-319	-132	-289	-398	-257	88
156	-179	-119	-273	-251	-287	-309	-316	-130	-288	-394	-255	87
157	-179	-118	-272	-250	-286	-308	-314	-130	-287	-393	-254	87
158	-179	-120	-276	-254	-291	-311	-318	-130	-292	-400	-257	89
159	-186	-126	-289	-263	-302	-324	-329	-135	-301	-416	-267	92

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
160	-190	-129	-294	-267	-307	-329	-335	-138	-306	-421	-271	93
161	-189	-126	-288	-265	-304	-326	-333	-136	-304	-418	-269	92
162	-187	-126	-289	-264	-304	-323	-331	-137	-302	-417	-268	92
163	-190	-130	-294	-268	-308	-329	-336	-139	-306	-423	-272	93
164	-191	-132	-295	-268	-308	-332	-338	-140	-307	-421	-273	92
165	-189	-128	-293	-264	-303	-328	-333	-138	-301	-412	-269	91
166	-187	-126	-287	-261	-298	-325	-329	-136	-297	-407	-265	90
167	-188	-127	-289	-262	-300	-326	-330	-137	-299	-408	-267	90
168	-191	-129	-293	-267	-305	-332	-337	-139	-303	-416	-271	92
169	-194	-133	-298	-274	-312	-337	-343	-142	-310	-428	-277	94
170	-197	-136	-306	-281	-318	-344	-351	-144	-319	-437	-283	96
171	-202	-139	-315	-286	-325	-353	-359	-148	-325	-448	-290	99
172	-204	-142	-319	-288	-327	-357	-362	-150	-328	-451	-293	99
173	-205	-141	-317	-288	-326	-356	-361	-150	-327	-446	-292	98
174	-205	-140	-316	-287	-325	-355	-361	-149	-326	-443	-291	97
175	-206	-140	-314	-285	-323	-357	-361	-150	-324	-441	-290	97
176	-204	-138	-311	-283	-321	-354	-358	-149	-320	-439	-288	96
177	-204	-138	-311	-284	-321	-353	-359	-148	-322	-440	-288	97
178	-205	-138	-311	-284	-322	-355	-360	-149	-323	-441	-289	97
179	-205	-137	-310	-284	-320	-353	-360	-149	-322	-440	-288	97
180	-206	-137	-311	-284	-320	-353	-361	-150	-323	-438	-288	96
181	-206	-137	-309	-282	-318	-352	-359	-150	-321	-434	-287	95
182	-206	-137	-308	-281	-315	-351	-357	-150	-319	-430	-285	94
183	-204	-132	-298	-275	-308	-342	-351	-148	-311	-418	-279	91
184	-197	-127	-288	-265	-299	-329	-339	-143	-301	-403	-269	88
185	-190	-121	-277	-255	-287	-313	-325	-137	-291	-388	-258	85
186	-187	-119	-270	-251	-282	-307	-320	-135	-286	-379	-254	83
187	-181	-116	-259	-237	-266	-297	-307	-132	-270	-358	-242	78
188	-182	-117	-259	-238	-266	-297	-307	-132	-270	-357	-243	77
189	-183	-117	-261	-239	-269	-297	-309	-133	-273	-361	-244	78
190	-183	-116	-263	-241	-270	-295	-309	-133	-276	-360	-245	78
191	-184	-117	-262	-242	-268	-293	-309	-134	-276	-357	-244	77
192	-182	-117	-260	-242	-267	-288	-307	-133	-277	-355	-243	76
193	-184	-119	-262	-246	-271	-287	-311	-135	-283	-361	-246	77
194	-183	-117	-259	-241	-265	-282	-307	-134	-277	-351	-242	75
195	-179	-112	-250	-233	-256	-271	-296	-131	-269	-336	-233	72
196	-173	-110	-243	-225	-247	-260	-287	-128	-260	-325	-226	69
197	-170	-108	-237	-219	-240	-254	-280	-125	-252	-313	-220	66
198	-164	-104	-229	-215	-234	-243	-271	-121	-247	-304	-213	64
199	-159	-102	-223	-209	-226	-233	-262	-118	-239	-293	-206	61



Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
200	-154	-100	-218	-202	-219	-226	-255	-115	-233	-281	-200	59
201	-155	-100	-220	-203	-220	-226	-255	-115	-234	-284	-201	60
202	-156	-103	-223	-204	-223	-228	-257	-116	-235	-288	-203	60
203	-152	-101	-220	-199	-219	-224	-252	-114	-229	-283	-199	59
204	-147	-98	-215	-193	-213	-218	-244	-111	-223	-274	-194	57
205	-147	-100	-214	-193	-213	-218	-245	-111	-223	-276	-194	57
206	-148	-102	-218	-195	-215	-221	-248	-112	-225	-278	-196	58
207	-148	-103	-219	-195	-215	-221	-246	-112	-225	-282	-196	58
208	-147	-104	-219	-194	-215	-220	-246	-112	-225	-281	-196	58
209	-148	-105	-222	-192	-215	-220	-246	-112	-223	-280	-196	57
210	-148	-104	-221	-193	-217	-220	-248	-112	-225	-284	-197	58
211	-145	-100	-215	-188	-211	-216	-241	-110	-218	-273	-192	56
212	-136	-94	-202	-177	-198	-201	-225	-103	-206	-254	-179	52
213	-132	-92	-199	-173	-194	-197	-221	-101	-202	-251	-176	52
214	-135	-95	-203	-178	-201	-202	-228	-103	-208	-262	-182	54
215	-140	-99	-210	-183	-208	-210	-234	-106	-214	-271	-187	56
216	-143	-99	-213	-186	-209	-213	-238	-108	-216	-273	-190	56
217	-141	-97	-208	-182	-205	-209	-234	-106	-212	-265	-186	55
218	-139	-92	-200	-176	-196	-201	-226	-104	-204	-252	-179	52
219	-137	-90	-195	-173	-192	-197	-222	-103	-200	-248	-176	51
220	-136	-90	-193	-171	-190	-194	-220	-102	-199	-244	-174	50
221	-137	-91	-194	-172	-191	-195	-222	-104	-200	-244	-175	50
222	-133	-88	-188	-166	-184	-189	-214	-101	-192	-233	-169	47
223	-126	-82	-176	-155	-171	-176	-202	-97	-180	-214	-158	43
224	-120	-76	-163	-143	-158	-163	-188	-92	-167	-194	-146	39
225	-112	-71	-151	-135	-145	-150	-176	-86	-156	-177	-136	36
226	-109	-70	-149	-133	-143	-147	-173	-84	-155	-176	-134	36
227	-110	-70	-150	-133	-144	-146	-173	-85	-154	-177	-134	35
228	-107	-68	-146	-129	-140	-143	-168	-83	-150	-173	-131	34
229	-105	-67	-142	-125	-136	-139	-164	-82	-146	-168	-127	33
230	-103	-65	-137	-121	-133	-134	-159	-80	-143	-162	-124	32
231	-101	-65	-135	-119	-130	-131	-157	-79	-141	-159	-122	31
232	-99	-64	-133	-117	-129	-129	-154	-77	-139	-157	-120	31
233	-99	-64	-135	-117	-129	-129	-154	-78	-139	-158	-120	31
234	-100	-66	-138	-119	-131	-131	-156	-79	-141	-160	-122	32
235	-103	-68	-142	-122	-135	-136	-160	-81	-144	-166	-126	32
236	-105	-68	-142	-120	-133	-136	-158	-83	-142	-161	-125	31

Table C3. Net longshore transport rates, Plan 1, 1990–1999, 1,000 cu yd/yr.

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
1	-207	-90	-267	-220	-211	-385	-356	-53	-326	-419	-253	122
2	-194	-83	-249	-205	-198	-354	-335	-46	-308	-393	-237	114
3	-188	-81	-243	-195	-189	-342	-322	-43	-296	-378	-228	110
4	-183	-80	-240	-189	-186	-330	-313	-41	-289	-369	-222	107
5	-179	-78	-236	-184	-181	-321	-306	-38	-282	-360	-217	105
6	-177	-78	-235	-185	-182	-320	-304	-39	-280	-359	-216	104
7	-173	-79	-235	-184	-184	-315	-300	-39	-277	-359	-215	103
8	-174	-84	-244	-191	-193	-319	-303	-44	-281	-367	-220	103
9	-179	-94	-264	-205	-212	-329	-316	-52	-292	-390	-233	106
10	-192	-111	-294	-224	-235	-350	-338	-64	-311	-417	-254	110
11	-224	-143	-367	-282	-302	-419	-402	-88	-375	-516	-312	132
12	-237	-143	-365	-273	-281	-439	-412	-86	-377	-495	-311	131
13	-225	-118	-317	-239	-240	-411	-380	-69	-345	-446	-279	124
14	-203	-93	-265	-212	-205	-370	-348	-52	-317	-401	-246	116
15	-191	-82	-238	-193	-180	-345	-323	-47	-291	-362	-225	107
16	-182	-84	-239	-195	-192	-334	-316	-47	-288	-375	-225	107
17	-188	-94	-265	-212	-214	-347	-332	-55	-304	-401	-241	111
18	-201	-107	-288	-225	-225	-366	-350	-63	-320	-421	-257	114
19	-202	-104	-294	-237	-240	-376	-361	-60	-336	-448	-266	122
20	-199	-101	-286	-228	-229	-372	-352	-55	-328	-436	-259	120
21	-196	-97	-280	-221	-223	-367	-345	-50	-323	-428	-253	119
22	-196	-95	-277	-216	-215	-365	-343	-48	-321	-418	-249	118
23	-196	-95	-275	-213	-210	-365	-343	-47	-319	-413	-248	118
24	-199	-94	-273	-213	-210	-368	-344	-48	-320	-414	-248	118
25	-198	-91	-267	-210	-204	-369	-342	-46	-316	-406	-245	118
26	-193	-86	-254	-200	-193	-358	-333	-42	-308	-392	-236	115
27	-182	-78	-234	-194	-188	-336	-318	-39	-296	-381	-225	111
28	-177	-79	-238	-199	-197	-333	-315	-40	-297	-393	-227	112
29	-178	-85	-250	-205	-208	-335	-319	-44	-302	-407	-233	113
30	-183	-89	-260	-213	-219	-344	-327	-47	-309	-419	-241	115
31	-186	-91	-266	-213	-217	-347	-330	-47	-313	-418	-243	116
32	-184	-89	-262	-208	-214	-339	-324	-44	-308	-414	-238	115
33	-182	-90	-267	-209	-215	-341	-324	-44	-308	-414	-239	115
34	-192	-98	-280	-212	-218	-354	-335	-49	-314	-416	-247	116
35	-200	-101	-279	-205	-205	-360	-337	-50	-312	-398	-245	113
36	-191	-89	-258	-196	-193	-347	-326	-43	-302	-385	-233	112
37	-189	-87	-252	-197	-194	-345	-325	-43	-302	-384	-232	111
38	-187	-86	-255	-203	-202	-346	-328	-43	-306	-396	-235	113
39	-190	-89	-263	-214	-213	-351	-335	-49	-314	-410	-243	115

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
40	-190	-93	-266	-216	-217	-353	-336	-49	-317	-419	-246	116
41	-187	-90	-266	-212	-214	-348	-332	-46	-313	-415	-242	116
42	-185	-87	-258	-203	-203	-342	-324	-40	-305	-401	-235	114
43	-177	-78	-243	-187	-185	-322	-306	-31	-292	-376	-220	109
44	-166	-68	-224	-173	-169	-306	-288	-21	-278	-359	-205	107
45	-164	-68	-225	-175	-172	-308	-287	-19	-281	-366	-207	109
46	-164	-72	-219	-161	-156	-294	-278	-23	-261	-331	-196	99
47	-172	-85	-242	-179	-178	-313	-295	-35	-278	-354	-213	102
48	-184	-94	-262	-191	-192	-334	-314	-44	-291	-374	-228	106
49	-186	-90	-257	-189	-185	-339	-316	-39	-293	-376	-227	109
50	-188	-90	-265	-200	-200	-349	-326	-39	-307	-398	-236	114
51	-195	-96	-279	-211	-213	-364	-339	-43	-319	-415	-247	118
52	-201	-98	-281	-209	-208	-371	-345	-46	-320	-411	-249	118
53	-197	-88	-264	-201	-197	-363	-335	-37	-313	-405	-240	119
54	-193	-86	-258	-199	-195	-356	-331	-37	-311	-399	-236	117
55	-191	-85	-258	-201	-199	-353	-329	-39	-311	-399	-236	116
56	-190	-82	-248	-193	-190	-344	-321	-38	-302	-384	-229	112
57	-186	-81	-246	-195	-191	-340	-319	-36	-302	-387	-228	113
58	-186	-81	-250	-199	-197	-344	-322	-37	-305	-397	-232	115
59	-193	-91	-268	-210	-213	-354	-336	-43	-318	-415	-244	118
60	-198	-96	-277	-215	-217	-363	-344	-47	-324	-418	-250	118
61	-200	-92	-271	-207	-207	-362	-341	-43	-319	-410	-245	118
62	-192	-81	-251	-196	-192	-351	-328	-35	-310	-389	-233	116
63	-185	-76	-241	-194	-190	-343	-321	-30	-307	-394	-228	117
64	-184	-78	-247	-200	-200	-344	-323	-33	-311	-402	-232	117
65	-188	-84	-257	-207	-209	-352	-330	-37	-317	-414	-240	119
66	-192	-88	-264	-212	-213	-359	-337	-42	-321	-418	-244	119
67	-193	-88	-260	-206	-204	-356	-333	-42	-314	-403	-240	116
68	-189	-84	-254	-201	-201	-349	-328	-38	-312	-402	-236	116
69	-187	-81	-251	-199	-199	-344	-324	-35	-309	-400	-233	116
70	-186	-80	-250	-201	-203	-346	-326	-36	-311	-404	-234	117
71	-189	-85	-258	-213	-213	-355	-333	-41	-320	-419	-243	120
72	-197	-91	-269	-222	-225	-366	-347	-48	-329	-434	-253	122
73	-199	-92	-269	-219	-219	-368	-347	-49	-325	-422	-251	120
74	-195	-88	-261	-209	-208	-357	-336	-45	-317	-407	-242	117
75	-187	-77	-237	-194	-190	-339	-321	-37	-301	-385	-227	113
76	-181	-72	-229	-193	-190	-331	-315	-33	-300	-387	-223	113
77	-181	-76	-239	-196	-197	-333	-317	-33	-305	-398	-228	115
78	-186	-80	-252	-205	-209	-345	-326	-37	-315	-414	-237	118
79	-191	-83	-257	-210	-211	-353	-333	-39	-322	-420	-242	120

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
80	-193	-83	-254	-202	-202	-351	-331	-37	-316	-406	-237	118
81	-184	-70	-230	-185	-180	-334	-313	-28	-297	-378	-220	114
82	-171	-57	-204	-169	-164	-312	-292	-17	-280	-355	-202	110
83	-162	-54	-194	-164	-159	-299	-280	-15	-273	-351	-195	108
84	-166	-63	-211	-181	-181	-306	-292	-24	-289	-375	-209	110
85	-182	-81	-248	-206	-209	-340	-322	-38	-314	-416	-236	117
86	-194	-88	-265	-217	-221	-358	-340	-45	-327	-427	-248	120
87	-190	-84	-252	-209	-212	-349	-333	-41	-317	-414	-240	118
88	-186	-81	-245	-203	-205	-339	-325	-41	-308	-401	-233	114
89	-186	-80	-241	-201	-200	-336	-322	-41	-305	-393	-230	113
90	-184	-78	-240	-197	-195	-335	-318	-37	-301	-387	-227	112
91	-184	-77	-239	-196	-193	-335	-318	-35	-301	-389	-227	113
92	-182	-75	-234	-190	-188	-331	-314	-33	-298	-382	-223	112
93	-180	-73	-232	-190	-189	-330	-312	-32	-297	-384	-222	112
94	-181	-73	-233	-192	-190	-333	-314	-33	-300	-386	-223	113
95	-180	-70	-226	-187	-185	-330	-311	-31	-296	-381	-220	113
96	-174	-62	-210	-180	-175	-320	-302	-25	-287	-369	-211	111
97	-159	-45	-174	-143	-131	-281	-264	-11	-248	-305	-176	99
98	-159	-50	-186	-157	-150	-288	-272	-15	-261	-329	-187	102
99	-166	-58	-201	-168	-166	-301	-286	-21	-273	-351	-199	106
100	-169	-62	-209	-171	-170	-304	-289	-24	-275	-352	-202	105
101	-170	-65	-211	-172	-170	-305	-290	-27	-275	-352	-204	105
102	-172	-66	-212	-171	-170	-304	-291	-29	-274	-349	-204	104
103	-172	-63	-210	-171	-169	-304	-290	-28	-274	-349	-203	104
104	-169	-62	-206	-170	-168	-299	-287	-26	-273	-348	-201	104
105	-169	-63	-207	-172	-172	-299	-288	-27	-275	-354	-203	104
106	-172	-69	-221	-176	-179	-305	-292	-29	-282	-359	-208	105
107	-172	-65	-212	-170	-170	-303	-290	-27	-274	-350	-203	104
108	-170	-64	-209	-168	-166	-298	-287	-26	-271	-344	-200	103
109	-164	-58	-197	-159	-155	-288	-275	-21	-261	-326	-190	100
110	-160	-55	-193	-158	-155	-285	-273	-18	-261	-330	-189	101
111	-159	-56	-194	-161	-160	-286	-274	-18	-265	-339	-191	102
112	-163	-60	-203	-169	-170	-296	-284	-22	-273	-356	-200	106
113	-168	-63	-211	-176	-177	-305	-291	-24	-281	-366	-206	108
114	-172	-64	-214	-178	-178	-312	-297	-25	-285	-368	-209	109
115	-172	-62	-209	-173	-170	-307	-294	-23	-279	-356	-205	107
116	-165	-53	-190	-162	-157	-295	-280	-19	-267	-337	-192	104
117	-161	-51	-185	-158	-155	-289	-275	-18	-263	-334	-189	103
118	-160	-53	-188	-161	-161	-290	-277	-20	-264	-340	-191	103
119	-164	-58	-198	-172	-172	-296	-284	-27	-272	-353	-200	104

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
120	-166	-62	-202	-174	-175	-297	-289	-29	-275	-358	-203	105
121	-164	-63	-202	-173	-174	-294	-285	-30	-272	-355	-201	103
122	-164	-64	-202	-174	-175	-290	-284	-30	-272	-353	-201	102
123	-169	-69	-216	-182	-185	-302	-293	-35	-279	-366	-210	104
124	-170	-68	-216	-178	-180	-301	-292	-33	-277	-357	-207	103
125	-166	-63	-204	-169	-168	-290	-284	-28	-268	-343	-198	101
126	-160	-59	-195	-163	-162	-284	-276	-23	-264	-341	-193	101
127	-149	-43	-165	-131	-125	-256	-246	-8	-234	-287	-164	93
128	-146	-41	-162	-133	-126	-254	-244	-7	-234	-290	-164	93
129	-145	-44	-168	-139	-137	-256	-247	-9	-238	-302	-168	94
130	-153	-56	-186	-156	-156	-272	-263	-20	-254	-329	-185	98
131	-165	-68	-214	-174	-177	-295	-285	-30	-270	-353	-203	102
132	-169	-68	-215	-173	-173	-298	-288	-31	-270	-347	-203	101
133	-162	-61	-199	-163	-163	-285	-277	-26	-261	-336	-193	99
134	-162	-60	-199	-163	-164	-283	-274	-25	-261	-337	-193	99
135	-164	-62	-203	-166	-166	-288	-279	-25	-264	-338	-196	100
136	-165	-63	-204	-166	-167	-289	-279	-26	-265	-340	-196	100
137	-164	-63	-204	-166	-169	-288	-280	-27	-263	-341	-196	100
138	-166	-65	-208	-169	-172	-289	-281	-30	-265	-341	-199	99
139	-167	-66	-208	-167	-167	-288	-282	-31	-265	-335	-198	98
140	-166	-65	-205	-164	-164	-290	-280	-29	-262	-332	-196	98
141	-161	-58	-190	-157	-152	-279	-270	-24	-254	-319	-187	96
142	-157	-53	-185	-156	-151	-275	-266	-21	-253	-319	-184	97
143	-156	-54	-184	-157	-154	-275	-267	-20	-255	-327	-185	98
144	-157	-56	-191	-161	-160	-280	-271	-21	-259	-338	-189	100
145	-157	-57	-190	-161	-158	-278	-270	-21	-258	-334	-188	99
146	-157	-57	-191	-159	-158	-276	-269	-21	-257	-334	-188	99
147	-157	-57	-190	-160	-158	-275	-269	-21	-259	-332	-188	99
148	-159	-57	-191	-161	-158	-277	-271	-21	-260	-332	-189	99
149	-155	-51	-182	-152	-150	-270	-263	-15	-254	-320	-181	98
150	-151	-46	-172	-150	-144	-260	-257	-12	-252	-316	-176	97
151	-152	-49	-176	-153	-147	-261	-260	-14	-255	-319	-179	97
152	-154	-51	-180	-154	-150	-266	-262	-16	-255	-324	-181	98
153	-149	-43	-168	-142	-137	-253	-250	-10	-245	-303	-170	95
154	-143	-40	-154	-133	-124	-241	-239	-6	-233	-288	-160	91
155	-139	-38	-150	-129	-120	-234	-233	-4	-229	-283	-156	90
156	-137	-36	-149	-126	-119	-230	-230	-1	-228	-279	-154	90
157	-136	-35	-148	-126	-118	-230	-229	-1	-227	-278	-153	90
158	-137	-39	-153	-132	-126	-234	-235	-4	-232	-288	-158	91
159	-145	-47	-169	-144	-141	-249	-247	-11	-244	-305	-170	93

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
160	-149	-49	-174	-147	-146	-254	-253	-15	-248	-311	-174	94
161	-148	-48	-169	-147	-145	-251	-252	-14	-247	-309	-173	94
162	-147	-49	-173	-149	-147	-249	-252	-17	-246	-310	-174	93
163	-151	-54	-181	-153	-154	-256	-258	-20	-250	-318	-180	94
164	-152	-56	-183	-154	-154	-258	-260	-21	-251	-316	-180	94
165	-151	-53	-182	-149	-151	-255	-255	-20	-246	-307	-177	92
166	-149	-51	-177	-148	-148	-252	-252	-20	-242	-304	-174	91
167	-150	-52	-179	-149	-151	-253	-253	-20	-243	-306	-176	91
168	-153	-54	-181	-153	-154	-258	-259	-22	-248	-312	-180	93
169	-155	-59	-187	-162	-163	-264	-266	-25	-254	-326	-186	95
170	-159	-63	-197	-172	-171	-273	-276	-30	-265	-337	-194	97
171	-165	-67	-209	-177	-179	-282	-285	-34	-272	-349	-202	99
172	-167	-69	-212	-178	-179	-286	-287	-35	-274	-351	-204	100
173	-167	-67	-209	-177	-177	-285	-286	-34	-273	-346	-202	99
174	-167	-65	-205	-175	-175	-283	-285	-33	-271	-342	-200	99
175	-167	-64	-202	-172	-172	-283	-284	-32	-268	-337	-198	98
176	-165	-62	-200	-169	-170	-280	-281	-31	-264	-336	-196	98
177	-165	-61	-198	-169	-168	-279	-281	-29	-265	-336	-195	98
178	-166	-61	-199	-170	-169	-281	-283	-30	-267	-337	-196	99
179	-166	-61	-198	-170	-168	-280	-283	-29	-266	-336	-196	99
180	-167	-60	-195	-169	-164	-279	-281	-29	-266	-332	-194	98
181	-166	-58	-192	-164	-159	-277	-278	-27	-263	-327	-191	97
182	-165	-56	-188	-162	-153	-276	-275	-25	-261	-321	-188	97
183	-161	-48	-172	-152	-141	-264	-266	-20	-251	-305	-178	95
184	-154	-43	-160	-140	-129	-251	-253	-14	-241	-289	-167	92
185	-146	-36	-146	-130	-118	-234	-239	-9	-231	-274	-156	89
186	-143	-34	-140	-127	-114	-229	-235	-7	-226	-265	-152	87
187	-142	-37	-141	-121	-109	-223	-226	-12	-214	-251	-148	82
188	-143	-39	-144	-123	-112	-223	-227	-13	-214	-251	-149	81
189	-144	-38	-144	-122	-112	-222	-228	-13	-216	-254	-149	82
190	-143	-34	-139	-120	-107	-218	-225	-8	-217	-250	-146	82
191	-143	-35	-136	-119	-104	-214	-225	-8	-216	-246	-145	82
192	-142	-36	-139	-123	-107	-212	-226	-10	-219	-246	-146	81
193	-142	-36	-136	-122	-104	-209	-225	-8	-223	-248	-145	82
194	-140	-32	-129	-115	-96	-202	-220	-5	-216	-235	-139	80
195	-136	-26	-119	-107	-88	-191	-209	-1	-208	-220	-130	77
196	-130	-24	-113	-99	-79	-180	-200	1	-198	-210	-123	75
197	-127	-23	-108	-95	-74	-174	-193	1	-191	-200	-119	72
198	-119	-18	-95	-89	-65	-162	-183	7	-185	-188	-110	71
199	-115	-16	-91	-83	-59	-152	-175	10	-178	-178	-104	68

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
200	-111	-14	-88	-75	-50	-146	-167	13	-172	-166	-98	66
201	-111	-15	-91	-77	-52	-147	-168	13	-173	-170	-99	67
202	-112	-19	-95	-79	-56	-150	-171	10	-175	-175	-102	67
203	-109	-17	-93	-75	-53	-146	-166	13	-169	-170	-98	66
204	-104	-14	-89	-69	-47	-140	-158	16	-163	-162	-93	64
205	-104	-17	-88	-70	-49	-141	-160	15	-163	-164	-94	64
206	-107	-21	-97	-76	-57	-145	-166	11	-167	-169	-99	64
207	-108	-26	-103	-79	-61	-147	-166	7	-168	-175	-103	63
208	-108	-27	-105	-78	-62	-146	-167	6	-169	-177	-103	63
209	-108	-28	-107	-76	-61	-146	-165	7	-167	-175	-103	63
210	-107	-24	-102	-74	-58	-144	-165	11	-167	-175	-101	64
211	-103	-19	-94	-66	-50	-138	-157	15	-159	-163	-93	63
212	-94	-13	-80	-56	-38	-124	-141	20	-147	-145	-82	59
213	-92	-13	-80	-54	-36	-121	-138	21	-144	-144	-80	58
214	-95	-15	-86	-59	-42	-126	-145	20	-149	-154	-85	60
215	-99	-18	-92	-63	-49	-133	-152	18	-155	-162	-90	62
216	-101	-16	-91	-61	-45	-134	-152	20	-155	-160	-89	63
217	-97	-10	-81	-55	-36	-127	-145	25	-150	-149	-83	62
218	-94	-4	-68	-46	-26	-117	-136	28	-140	-135	-74	60
219	-92	-2	-63	-43	-22	-114	-133	29	-137	-131	-71	60
220	-93	-4	-64	-45	-24	-112	-132	26	-137	-129	-71	58
221	-95	-6	-67	-46	-27	-114	-135	24	-138	-131	-73	58
222	-90	-1	-59	-37	-18	-105	-126	28	-129	-118	-66	56
223	-82	10	-38	-21	0	-90	-109	37	-114	-96	-50	55
224	-74	20	-19	-4	17	-71	-92	45	-98	-70	-35	52
225	-66	25	-7	3	28	-59	-81	50	-87	-54	-25	50
226	-64	24	-8	3	28	-56	-80	50	-87	-55	-25	50
227	-66	22	-13	2	24	-56	-80	48	-87	-57	-26	49
228	-63	25	-9	7	27	-52	-75	50	-82	-53	-22	48
229	-61	27	-4	12	31	-47	-70	52	-77	-47	-18	47
230	-58	31	1	18	34	-40	-64	55	-73	-40	-14	47
231	-56	31	2	21	37	-37	-61	56	-70	-37	-11	46
232	-54	32	3	23	38	-35	-58	58	-68	-34	-9	46
233	-55	31	-1	24	37	-33	-58	59	-68	-35	-10	46
234	-56	31	-4	25	37	-35	-59	61	-68	-34	-10	46
235	-57	33	-2	29	41	-35	-58	65	-68	-34	-9	48
236	-55	44	14	47	58	-24	-45	78	-59	-16	4	51

(Sheet 6 of 6)

Table C4. Gross longshore transport rates, Plan 1, 1990–1999, 1,000 cu yd/yr.

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
1	288	252	506	460	546	531	520	304	440	641	449	128
2	272	242	480	438	521	498	494	291	420	609	426	121
3	263	236	467	425	505	484	476	283	407	591	414	117
4	256	233	457	417	494	471	466	279	398	579	405	114
5	252	229	451	411	487	462	458	275	391	568	398	112
6	248	227	446	405	481	458	453	271	388	562	394	111
7	244	225	444	400	478	451	445	265	383	558	389	111
8	240	223	439	399	474	450	440	262	383	555	386	110
9	242	226	445	403	475	457	446	260	391	570	392	114
10	250	238	460	416	483	477	461	266	408	590	405	117
11	283	272	533	476	554	548	525	293	473	689	464	139
12	302	288	557	491	567	578	551	315	484	695	483	138
13	298	273	534	472	551	555	533	312	458	659	464	129
14	283	254	498	448	530	516	507	300	430	619	438	122
15	268	235	462	419	492	485	476	284	400	572	409	112
16	255	226	450	409	485	469	460	270	393	569	399	113
17	256	232	461	418	494	480	469	271	406	590	408	118
18	266	245	478	433	504	500	486	281	423	607	422	120
19	273	250	499	453	535	515	503	289	443	646	441	130
20	271	252	497	452	535	513	502	291	438	640	439	128
21	270	250	499	449	536	510	498	290	434	635	437	128
22	272	253	500	450	535	511	499	293	434	634	438	127
23	273	254	499	449	534	511	501	295	433	632	438	125
24	276	254	499	450	534	514	502	297	433	634	439	125
25	278	255	502	452	536	517	505	300	432	629	441	124
26	274	250	493	442	529	505	497	295	423	618	433	122
27	264	236	472	429	515	480	478	283	408	600	416	119
28	255	230	465	421	509	472	468	273	404	598	410	120
29	251	229	461	420	506	471	464	269	407	603	408	122
30	253	232	470	427	514	481	470	272	415	615	415	125
31	257	238	479	433	520	488	477	279	421	621	421	125
32	255	238	475	430	520	481	473	278	417	619	419	125
33	251	239	472	430	513	482	470	277	416	614	416	123
34	261	249	487	440	520	498	484	286	426	620	427	123
35	272	258	496	444	520	509	494	295	427	616	433	120
36	267	249	482	435	513	495	486	291	416	602	424	118
37	266	244	478	431	512	491	482	288	414	600	421	118
38	265	242	481	434	519	491	484	285	418	610	423	121
39	265	240	482	439	522	493	486	283	423	617	425	124

(Sheet 1 of 6)



Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
40	264	243	483	438	523	493	486	283	425	622	426	125
41	261	241	484	438	524	491	483	283	423	620	425	125
42	260	244	480	437	522	488	480	285	418	613	423	122
43	253	242	471	427	513	472	467	283	408	598	413	118
44	245	235	462	419	507	459	455	279	397	586	404	117
45	246	237	468	423	517	461	457	280	400	596	408	119
46	237	231	443	399	477	441	436	271	376	547	386	107
47	242	235	452	404	480	454	444	270	387	560	393	110
48	252	245	466	418	489	477	462	279	401	580	407	113
49	258	249	478	429	505	488	474	287	408	593	417	116
50	262	251	489	440	523	497	485	289	422	619	428	123
51	270	258	506	453	538	514	500	296	435	638	441	127
52	277	264	512	457	540	523	508	303	438	640	446	126
53	277	260	507	457	543	519	507	304	435	639	445	126
54	274	256	502	453	541	510	501	301	431	630	440	125
55	271	252	496	446	535	503	495	295	428	626	434	124
56	267	248	484	439	523	494	486	293	419	609	426	120
57	265	246	483	438	527	490	484	291	418	612	425	121
58	264	245	487	440	530	492	485	289	420	620	427	124
59	269	250	494	447	535	501	494	291	432	633	435	126
60	274	256	503	454	540	511	503	297	438	639	441	127
61	278	260	506	456	540	514	507	302	438	639	444	126
62	275	254	499	453	542	505	501	302	430	629	439	124
63	272	251	501	451	548	497	498	299	428	634	438	126
64	268	247	496	449	545	494	493	293	429	634	435	127
65	271	250	501	452	549	501	497	294	433	641	439	129
66	273	251	504	452	547	506	500	295	435	642	440	129
67	273	251	497	447	536	503	497	295	429	627	435	124
68	271	249	496	447	540	498	495	294	428	628	435	125
69	269	247	494	445	538	494	492	293	425	626	432	125
70	269	247	496	448	543	496	494	293	428	633	435	127
71	271	247	499	451	548	501	497	292	434	641	438	129
72	277	250	501	456	548	511	506	293	441	652	444	131
73	277	250	498	452	538	512	504	294	437	639	440	127
74	274	247	495	446	536	503	499	294	430	627	435	125
75	268	241	479	438	524	489	487	290	416	610	424	121
76	265	237	476	436	527	481	483	287	416	613	422	123
77	263	241	483	439	534	482	483	287	421	624	426	125
78	268	243	494	446	545	494	492	290	431	637	434	129
79	272	247	500	453	550	502	499	295	438	646	440	130

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
80	276	252	502	455	547	505	502	300	435	638	441	127
81	271	246	490	445	536	494	491	299	421	620	431	123
82	262	236	473	433	527	472	476	292	405	600	418	119
83	253	229	463	421	519	456	460	283	395	591	407	118
84	252	229	462	424	518	455	460	277	404	601	408	121
85	263	241	488	442	539	485	483	285	427	635	429	128
86	275	250	505	455	552	505	501	294	441	650	443	131
87	272	246	494	448	543	497	496	291	431	636	435	127
88	267	239	482	438	529	485	485	285	420	618	425	124
89	266	238	477	435	523	482	482	285	417	610	421	122
90	265	238	476	434	521	482	481	286	414	607	420	121
91	265	239	479	437	525	484	482	287	416	610	423	122
92	265	240	480	436	524	482	482	289	415	610	422	121
93	265	240	481	436	527	482	481	289	415	612	423	122
94	266	240	483	438	530	484	483	289	417	615	424	123
95	267	238	482	436	530	485	484	290	415	613	424	122
96	264	233	473	433	525	476	478	288	408	603	418	121
97	247	220	441	402	488	440	444	278	371	545	388	107
98	246	221	446	407	497	441	447	276	381	563	392	112
99	252	225	453	414	506	454	456	277	391	580	401	116
100	250	226	451	413	500	454	455	276	391	578	400	115
101	250	225	447	410	494	453	453	275	390	571	397	113
102	250	224	446	409	491	453	453	275	389	568	396	112
103	251	223	445	409	492	453	454	276	389	568	396	112
104	249	222	443	408	492	449	451	275	388	568	394	112
105	247	221	443	409	495	448	449	273	389	573	395	114
106	250	226	453	414	500	453	454	276	396	578	400	115
107	251	226	449	413	497	455	455	279	391	574	399	113
108	251	226	447	410	493	451	453	278	388	567	396	111
109	246	223	439	404	484	441	443	275	378	551	389	108
110	245	221	442	406	491	439	443	275	380	558	390	110
111	244	221	442	406	495	440	443	273	383	565	391	112
112	248	223	448	411	502	448	451	275	390	580	398	116
113	252	226	455	418	510	457	458	278	398	590	404	118
114	257	231	463	426	517	466	467	284	404	596	411	119
115	259	232	466	425	515	464	468	285	400	591	411	117
116	253	224	452	417	504	453	457	281	389	573	400	114
117	250	219	447	408	499	445	449	276	383	567	394	113
118	247	217	442	407	495	443	446	273	382	568	392	113
119	247	215	440	405	493	445	446	270	385	569	392	114

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
120	248	217	441	406	492	445	448	269	387	571	392	114
121	244	215	436	400	486	438	442	265	383	565	387	113
122	241	213	430	399	481	433	438	262	381	559	384	112
123	244	216	435	402	484	445	442	264	387	568	389	113
124	247	219	439	405	486	446	446	268	388	563	391	112
125	245	218	435	402	482	439	443	269	381	556	387	110
126	241	216	433	399	484	434	438	268	379	558	385	111
127	233	209	414	382	461	414	418	267	355	517	367	101
128	231	208	413	383	463	412	416	265	354	519	367	102
129	228	205	410	378	461	408	413	260	354	522	364	103
130	231	209	418	386	469	417	421	259	366	540	372	107
131	239	217	430	397	479	438	437	264	379	557	384	111
132	244	219	434	400	478	442	441	268	380	554	386	109
133	238	214	425	392	473	430	432	264	372	546	378	108
134	237	214	424	393	475	428	430	264	372	547	378	108
135	241	217	431	398	480	434	437	267	376	552	383	109
136	242	217	432	399	480	436	438	267	378	554	384	110
137	240	215	425	395	473	434	434	265	376	549	381	108
138	240	215	423	393	470	433	433	263	375	545	379	107
139	241	217	424	393	467	433	435	266	375	541	379	106
140	243	218	428	395	470	438	437	269	375	543	381	106
141	240	214	422	391	468	429	431	268	368	534	377	104
142	239	211	422	392	471	426	429	266	368	535	376	105
143	238	213	422	393	475	425	429	266	369	545	377	107
144	238	213	426	394	479	429	432	265	373	551	380	109
145	236	212	422	393	475	425	430	264	371	547	377	109
146	235	212	423	391	474	424	428	263	370	546	377	108
147	235	212	422	392	475	423	428	263	372	545	377	108
148	237	214	425	395	478	425	432	266	375	547	379	108
149	238	215	425	397	480	425	432	269	372	546	380	108
150	236	211	420	396	478	415	427	267	370	542	376	107
151	237	213	421	397	478	415	429	268	373	544	377	107
152	238	214	424	397	480	420	430	268	373	547	379	108
153	233	210	415	390	471	410	421	266	365	532	371	104
154	227	206	407	380	462	398	410	262	353	518	362	102
155	224	204	402	378	459	391	405	261	349	514	359	101
156	221	203	397	375	456	387	402	260	348	508	356	100
157	221	201	397	375	455	386	400	259	347	507	355	100
158	221	201	399	376	456	388	402	256	351	512	356	101
159	227	206	410	383	463	399	411	258	359	526	364	104

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
160	230	208	414	387	468	405	417	261	363	531	369	105
161	229	204	408	383	463	402	414	259	361	527	365	104
162	227	202	404	380	460	398	410	256	359	523	362	103
163	229	206	406	383	462	403	414	258	362	528	365	104
164	230	208	407	383	461	405	416	259	363	527	366	103
165	228	204	404	378	454	402	410	257	357	516	361	101
166	225	201	397	373	448	398	405	253	353	510	356	100
167	226	202	400	374	449	399	407	254	354	511	358	100
168	230	204	405	380	456	405	414	257	359	519	363	102
169	233	208	410	386	462	410	419	258	365	530	368	104
170	235	209	415	391	466	415	425	257	373	536	372	106
171	239	211	422	394	472	424	432	261	379	547	378	108
172	242	215	426	398	476	428	436	265	383	550	382	109
173	243	214	425	398	475	428	437	265	382	547	381	107
174	243	214	426	398	475	428	436	265	381	545	381	107
175	245	215	427	399	474	430	438	268	380	545	382	107
176	243	214	423	396	472	427	435	267	376	543	380	106
177	244	214	424	398	474	427	437	268	378	544	381	106
178	245	214	423	398	475	428	438	269	379	545	381	107
179	244	214	422	398	473	427	438	268	379	543	381	106
180	245	215	426	399	476	427	440	270	379	544	382	106
181	246	216	427	400	477	426	439	272	378	541	382	106
182	247	217	427	401	478	427	440	274	376	539	382	105
183	247	215	425	397	475	420	435	276	370	531	379	103
184	240	211	415	390	468	407	425	272	361	517	371	100
185	233	207	407	380	457	391	412	266	351	502	361	97
186	230	203	399	376	450	385	406	263	346	493	355	95
187	220	195	378	354	423	372	387	252	327	465	337	89
188	221	195	375	353	420	372	386	252	327	462	336	88
189	222	196	379	357	426	373	389	254	330	468	339	89
190	224	198	386	363	433	373	393	258	335	470	343	90
191	225	200	387	365	433	371	394	261	337	469	344	89
192	222	198	381	361	427	364	389	256	335	464	340	88
193	226	203	389	370	438	366	397	263	343	475	347	90
194	226	203	389	367	434	362	395	263	338	467	344	88
195	222	198	381	359	425	351	384	260	330	451	336	84
196	216	196	374	352	415	340	374	256	321	440	328	82
197	212	192	365	344	406	333	366	252	312	425	321	79
198	208	191	363	341	403	324	359	250	308	419	317	78
199	202	188	354	335	393	313	349	245	300	408	309	75

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
200	198	186	348	329	388	306	342	244	295	395	303	73
201	198	185	349	329	389	306	343	243	295	398	303	74
202	199	187	351	328	390	307	343	243	295	401	305	74
203	195	185	347	323	385	303	338	240	289	396	300	73
204	190	182	341	317	379	297	329	237	283	387	294	72
205	190	183	340	316	378	296	330	236	282	387	294	72
206	190	183	338	314	373	298	330	235	284	387	293	71
207	188	180	335	310	370	295	327	231	281	388	290	71
208	187	181	334	309	369	294	326	230	281	385	289	71
209	187	183	336	308	370	294	326	232	280	385	290	70
210	189	184	340	312	376	297	330	235	283	393	294	72
211	186	182	336	309	372	293	325	234	278	383	290	71
212	177	175	325	297	358	277	309	226	264	363	277	67
213	173	172	317	292	352	272	304	223	260	359	272	66
214	175	176	320	297	359	279	310	226	266	370	278	69
215	181	179	327	303	368	287	317	230	273	381	285	70
216	185	183	336	310	374	292	324	236	276	386	290	71
217	184	183	336	310	374	290	322	237	274	381	289	70
218	183	180	332	306	366	285	316	237	268	370	284	68
219	181	178	326	303	362	280	312	234	263	365	281	67
220	180	176	322	298	356	276	308	231	261	358	277	65
221	180	177	322	298	355	277	309	232	262	358	277	65
222	176	175	318	294	349	272	303	231	256	349	272	63
223	171	174	314	288	343	263	295	230	245	333	266	61
224	166	172	307	282	333	254	284	229	236	318	258	58
225	158	166	295	272	318	242	271	222	225	299	247	55
226	155	164	290	269	314	237	267	219	223	297	243	54
227	154	163	287	267	311	236	265	217	222	297	242	54
228	152	162	282	264	307	234	261	217	218	293	239	53
229	150	161	279	261	303	231	258	216	216	289	237	52
230	147	161	276	259	300	228	255	215	213	284	234	51
231	145	160	273	258	298	226	253	214	212	282	232	51
232	143	159	270	257	296	224	250	213	210	280	230	50
233	143	160	269	257	294	225	250	215	211	282	230	50
234	144	163	272	262	299	228	254	218	214	286	234	51
235	149	169	283	272	311	237	262	227	219	297	243	53
236	155	181	297	286	325	248	271	243	226	306	254	55

(Sheet 6 of 6)

## **Appendix D: Average Annual Changes in Longshore Transport Rates Between Plan 1 and Existing Bathymetry<sup>1,2</sup>**

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<sup>1</sup> This appendix contains Figures and tables for south, north, net, and gross longshore transport rates.

<sup>2</sup> Values in tables show two decimal-place accuracy to better highlight difference because of small values of numbers.

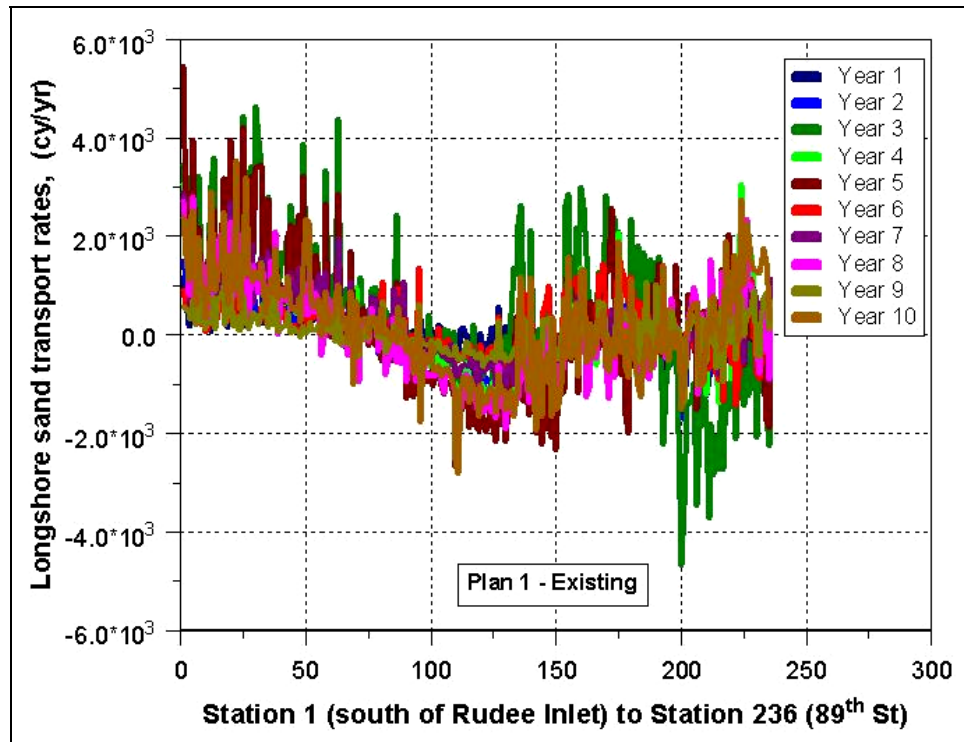


Figure D1. Average annual change in southerly longshore transport rates for monitoring stations, Plan 1 - Existing bathymetry.

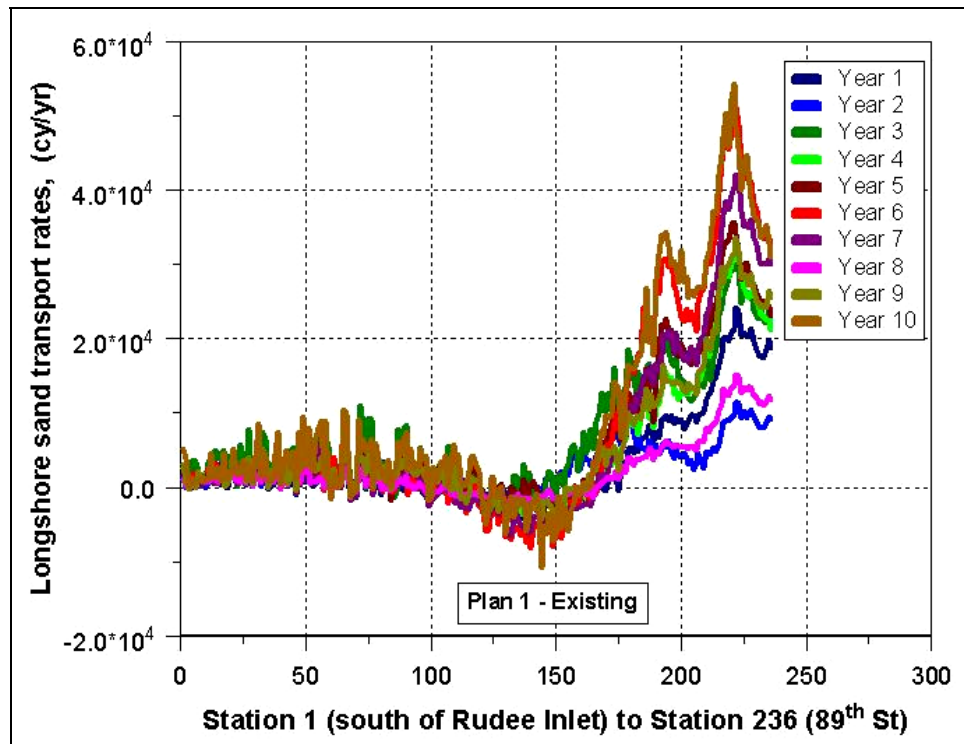


Figure D2. Average annual change in northerly longshore transport rates for monitoring stations, Plan 1 - Existing bathymetry.

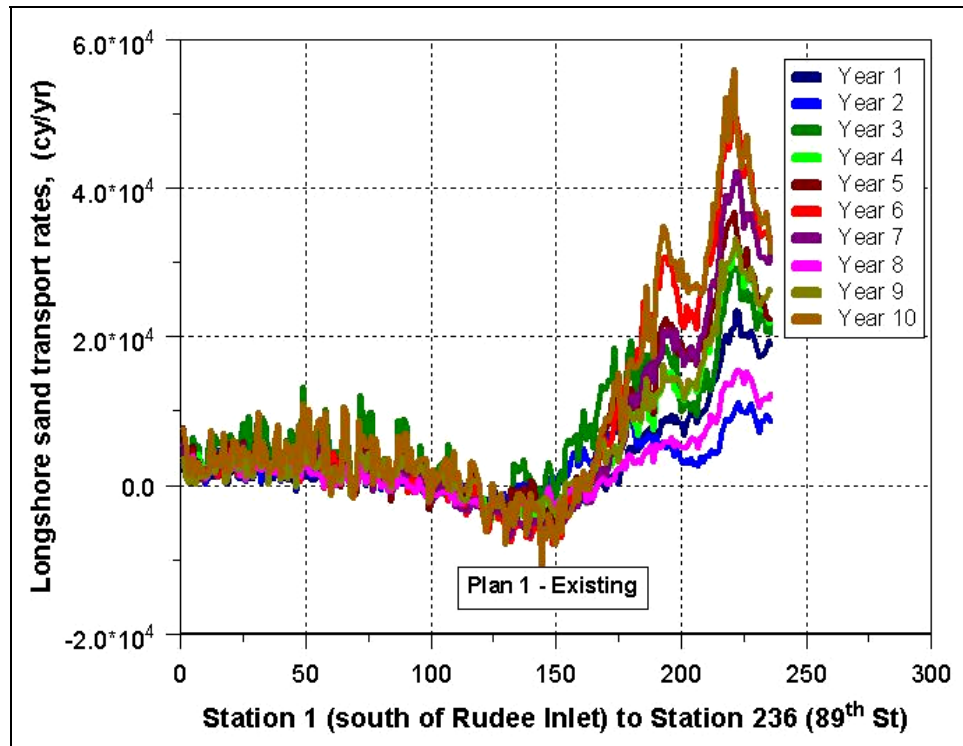


Figure D3. Average annual change in net longshore transport rates for monitoring stations, Plan 1 – Existing bathymetry.

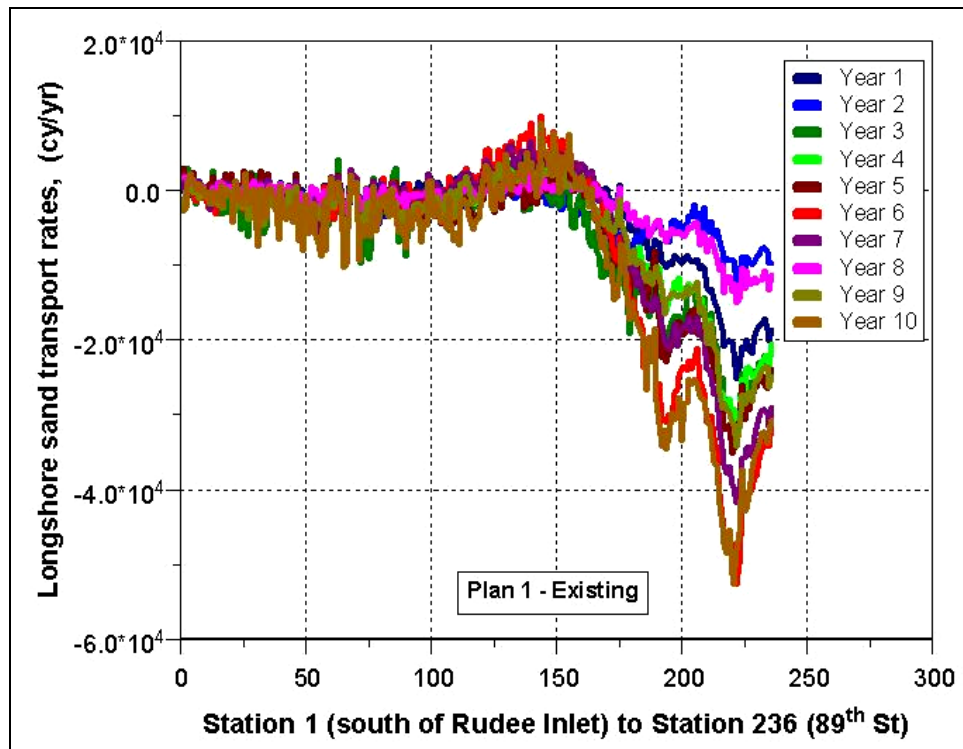


Figure D4. Average annual change in gross longshore transport rates for monitoring stations, Plan 1 – Existing bathymetry.



Table D1. Southern longshore transport rates, change = P1 - Ex, 1990-1999, 1,000 cu yd/yr.

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
1	1.16	1.51	3.44	3.06	5.45	0.91	2.90	2.72	0.58	2.37	2.41	1.46
2	0.71	1.17	2.40	1.96	2.14	0.61	1.81	1.95	0.54	1.62	1.49	0.68
3	0.21	0.90	3.19	1.24	2.90	0.60	0.90	0.85	0.47	1.11	1.24	1.00
4	0.19	0.95	1.15	0.88	1.13	0.41	0.59	0.79	0.31	2.34	0.87	0.61
5	0.66	1.45	2.95	3.38	3.95	1.28	2.14	2.80	0.72	2.51	2.18	1.13
6	0.28	0.55	1.74	0.95	1.22	0.30	0.73	0.82	0.21	0.62	0.74	0.47
7	0.80	2.05	3.24	2.06	2.18	1.13	1.67	1.93	1.02	1.99	1.81	0.70
8	0.50	0.74	1.27	0.96	1.22	0.20	0.75	0.57	0.23	0.93	0.74	0.37
9	0.62	1.05	1.27	1.11	1.04	0.56	1.35	1.45	0.74	1.01	1.02	0.30
10	0.07	0.22	0.26	0.37	0.43	0.07	0.27	0.30	0.12	0.34	0.25	0.13
11	0.55	0.44	1.54	0.52	1.47	0.14	0.48	0.56	0.26	0.89	0.69	0.47
12	0.07	1.14	3.04	1.10	2.59	0.33	0.92	0.76	0.23	2.93	1.31	1.13
13	0.52	1.15	3.60	1.31	2.56	0.69	1.85	1.49	0.78	1.25	1.52	0.94
14	0.35	1.01	1.76	0.62	0.93	0.19	0.82	1.04	0.13	0.89	0.77	0.48
15	0.42	1.65	1.37	1.77	1.99	0.43	0.77	1.89	0.73	1.25	1.23	0.60
16	0.99	1.37	1.88	1.80	1.40	0.92	1.38	2.04	0.77	1.57	1.41	0.43
17	0.48	1.32	1.80	1.90	3.17	1.09	1.88	1.95	1.00	2.51	1.71	0.78
18	0.34	0.54	2.94	1.72	3.19	0.26	1.25	0.90	0.20	1.05	1.24	1.07
19	0.16	0.74	1.19	1.14	1.30	0.29	0.44	1.10	0.44	0.63	0.74	0.41
20	0.59	1.37	2.92	3.17	3.96	0.72	2.69	2.30	0.84	1.65	2.02	1.16
21	0.33	0.57	1.97	0.65	1.38	0.57	1.03	0.77	0.19	0.92	0.84	0.53
22	1.05	1.51	2.66	1.36	2.10	0.85	1.50	1.27	0.38	3.54	1.62	0.92
23	0.68	0.74	1.01	0.79	1.28	0.43	1.25	1.10	0.15	1.19	0.86	0.37
24	0.25	0.54	0.49	0.53	0.61	0.21	0.49	0.59	0.10	0.52	0.43	0.18
25	1.11	1.76	4.44	2.12	4.23	0.52	2.25	2.06	0.80	1.69	2.10	1.31
26	0.17	0.93	2.30	1.18	2.01	0.44	0.60	0.25	0.26	3.20	1.13	1.04
27	0.62	0.43	1.64	0.60	1.61	0.26	0.76	0.43	0.12	1.22	0.77	0.54
28	0.54	0.84	3.43	1.46	3.21	0.38	1.87	1.33	0.33	1.27	1.47	1.10
29	0.45	1.12	1.61	1.41	1.66	0.45	0.63	1.42	0.47	1.09	1.03	0.49
30	0.36	0.35	4.63	1.42	3.39	0.34	1.39	1.15	0.38	1.29	1.47	1.44
31	0.26	0.25	3.96	1.16	3.41	0.32	1.44	0.84	0.20	1.16	1.30	1.34
32	0.22	0.32	3.42	1.60	3.45	0.58	1.57	1.33	0.45	1.48	1.44	1.18
33	0.43	0.79	1.70	1.07	1.06	0.47	1.06	1.31	0.63	1.10	0.96	0.39
34	0.25	0.65	1.59	0.76	0.58	0.30	1.06	0.64	0.52	0.46	0.68	0.39
35	0.36	0.41	2.80	1.26	2.75	0.17	1.70	0.56	0.15	0.83	1.10	1.01
36	0.71	1.32	1.40	1.47	0.95	1.00	1.45	1.52	0.76	1.15	1.17	0.30
37	0.51	0.70	1.92	0.89	0.68	0.49	0.86	0.94	0.20	0.83	0.80	0.45
38	0.72	1.36	2.08	1.82	1.90	1.09	1.84	2.11	0.85	1.75	1.55	0.51
39	0.17	0.40	0.64	0.63	0.83	0.16	0.44	0.02	0.07	0.75	0.41	0.30

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
40	0.86	0.68	1.69	0.77	1.02	0.46	0.75	0.77	0.15	0.94	0.81	0.40
41	0.59	0.73	1.45	0.64	0.66	0.51	0.91	0.93	0.19	0.77	0.74	0.33
42	0.72	0.62	1.91	0.68	0.88	0.24	0.81	0.70	0.21	0.91	0.77	0.47
43	0.41	0.99	1.23	0.81	1.98	0.22	1.11	0.93	0.47	1.20	0.94	0.50
44	0.20	0.10	2.62	0.80	2.23	0.09	1.27	0.53	0.04	0.61	0.85	0.92
45	0.50	0.39	1.47	0.57	0.87	0.21	0.97	0.59	0.16	0.54	0.62	0.39
46	0.15	0.39	2.29	0.42	1.98	0.17	0.57	0.50	0.07	0.47	0.70	0.78
47	0.09	0.26	2.35	0.94	2.44	0.13	1.37	0.57	0.07	0.73	0.89	0.89
48	0.58	0.26	0.53	0.25	0.59	0.01	0.20	0.30	-0.04	0.28	0.30	0.22
49	0.88	0.83	3.87	1.96	3.23	0.63	1.61	1.12	0.18	1.41	1.57	1.17
50	0.23	0.53	1.40	0.59	0.41	0.17	0.57	0.41	0.03	2.35	0.67	0.70
51	0.48	0.69	1.21	0.58	0.65	0.37	0.82	0.41	0.11	2.30	0.76	0.61
52	0.24	0.41	0.81	0.78	0.90	0.30	0.74	1.14	0.26	0.82	0.64	0.31
53	0.33	0.44	0.55	0.56	0.39	0.34	0.74	0.47	0.10	0.54	0.45	0.17
54	0.31	0.45	1.84	1.62	1.63	0.45	0.96	0.86	0.09	0.60	0.88	0.62
55	0.31	0.38	1.15	1.17	1.17	0.42	1.23	0.43	0.22	0.73	0.72	0.42
56	-0.19	-0.09	0.35	0.23	-0.35	-0.04	-0.21	-0.42	-0.01	-0.01	-0.07	0.24
57	0.44	0.10	0.73	0.44	0.82	0.08	0.64	-0.07	0.05	0.39	0.36	0.31
58	0.43	0.48	3.34	1.06	2.65	0.27	1.28	0.71	0.20	0.90	1.13	1.05
59	0.49	0.49	0.74	0.53	0.33	0.49	0.61	0.73	0.47	0.22	0.51	0.16
60	0.21	0.13	0.47	0.19	-0.05	0.43	0.26	0.03	0.05	0.26	0.20	0.17
61	0.18	0.40	1.22	0.50	0.20	0.26	0.30	0.14	0.08	0.38	0.37	0.33
62	0.28	0.08	0.34	0.36	-0.03	-0.01	0.22	0.06	-0.13	0.76	0.19	0.26
63	0.77	0.89	4.37	1.38	2.85	0.82	1.94	0.87	0.70	1.03	1.56	1.20
64	0.23	-0.02	0.18	0.27	-0.07	0.08	0.02	-0.16	-0.19	0.57	0.09	0.23
65	-0.02	-0.07	0.85	0.08	-0.03	-0.03	0.16	-0.20	-0.08	0.21	0.09	0.29
66	-0.02	-0.27	0.94	0.11	0.31	-0.23	0.42	-0.22	-0.08	0.09	0.10	0.37
67	0.01	-0.24	0.59	-0.22	-0.35	-0.10	0.07	-0.41	-0.18	-0.12	-0.09	0.28
68	0.73	0.38	1.14	1.48	1.70	0.29	1.07	0.34	0.08	0.87	0.81	0.54
69	0.58	0.29	0.02	0.55	0.14	0.53	0.47	0.48	0.23	-1.02	0.23	0.48
70	0.31	0.65	0.57	0.98	0.14	0.60	0.61	0.49	0.30	0.69	0.53	0.24
71	0.17	-0.68	-0.54	-0.79	-0.68	-0.37	-0.18	-0.96	-0.43	-0.32	-0.48	0.33
72	0.12	0.16	1.17	0.27	0.09	0.02	0.03	-0.15	-0.01	0.27	0.20	0.37
73	0.30	0.09	0.16	-0.05	0.54	-0.01	0.31	0.05	-0.09	0.31	0.16	0.20
74	0.07	-0.06	0.24	0.28	0.28	0.22	0.20	0.27	0.12	0.36	0.20	0.12
75	-0.01	-0.21	0.19	-0.01	-0.21	0.29	0.03	-0.13	-0.07	0.02	-0.01	0.16
76	0.21	0.69	0.92	0.51	0.26	0.42	0.76	0.55	0.36	0.27	0.50	0.24
77	0.64	0.11	0.93	0.49	-0.14	0.75	0.27	0.36	0.22	0.36	0.40	0.32
78	0.63	0.37	0.95	0.37	-0.20	0.56	0.73	0.20	0.20	0.35	0.42	0.32
79	0.02	-0.39	0.09	-0.17	-0.20	-0.17	-0.16	-0.34	-0.06	0.05	-0.13	0.16

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
80	0.42	-0.20	0.89	0.33	-0.49	0.86	0.56	-0.06	-0.08	0.55	0.28	0.47
81	0.66	-0.08	0.22	0.60	-0.53	1.09	0.50	0.35	0.69	0.04	0.35	0.46
82	-0.09	-0.33	0.51	-0.45	-0.05	-0.36	0.09	-0.81	-0.34	0.00	-0.18	0.36
83	-0.02	-0.45	-0.05	-0.38	0.04	-0.25	-0.19	-0.52	-0.23	0.07	-0.20	0.21
84	0.19	-0.19	0.20	-0.22	-0.51	0.30	-0.04	-0.39	-0.05	-0.12	-0.08	0.26
85	0.27	-0.24	0.65	0.55	-0.06	0.47	0.95	0.35	0.21	0.10	0.32	0.35
86	0.04	-0.45	2.44	-0.31	1.10	-0.08	0.17	-0.56	-0.17	-0.16	0.20	0.91
87	0.67	0.21	0.87	0.51	-0.21	0.94	0.75	0.38	0.28	0.57	0.50	0.34
88	0.33	0.01	0.36	-0.24	-0.53	0.35	0.12	-0.57	-0.19	-0.12	-0.05	0.34
89	0.49	0.07	1.00	0.68	0.61	0.76	1.09	0.14	0.05	0.31	0.52	0.37
90	-0.04	-0.52	-0.27	-0.72	-1.28	-0.01	-0.60	-0.94	-0.28	-0.33	-0.50	0.40
91	-0.06	-0.16	0.05	-0.27	-0.46	-0.05	-0.13	-0.42	-0.17	-0.35	-0.20	0.17
92	-0.01	-0.38	-0.15	-0.29	-0.56	-0.01	-0.18	-0.50	-0.13	-0.13	-0.23	0.19
93	0.11	-0.38	-0.11	-0.20	-1.27	0.01	-0.15	-0.48	-0.08	-0.78	-0.33	0.42
94	-0.08	-0.57	-0.30	-0.63	-0.32	-0.36	-0.36	-0.94	-0.24	-0.49	-0.43	0.24
95	0.86	0.21	0.77	0.54	-0.49	1.35	0.28	0.26	0.64	0.48	0.49	0.49
96	0.36	-0.57	0.05	-0.45	-0.76	0.00	0.00	-0.43	-0.07	-1.76	-0.36	0.60
97	-0.06	-0.55	-0.32	-0.41	-0.58	-0.17	-0.32	-0.60	-0.19	-0.32	-0.35	0.18
98	-0.10	-0.61	-0.57	-0.58	-0.95	-0.21	-0.43	-0.82	-0.19	-0.57	-0.50	0.27
99	0.35	-0.34	0.40	-0.63	-0.92	-0.09	-0.11	-0.85	-0.23	-0.54	-0.30	0.45
100	-0.02	-0.13	-0.35	-0.38	-0.71	-0.28	-0.42	-0.77	-0.10	-0.17	-0.33	0.25
101	-0.09	-0.52	-0.44	-0.72	-1.03	-0.37	-0.39	-0.84	-0.36	-0.66	-0.54	0.27
102	-0.01	-0.82	-0.50	-0.58	-0.82	-0.22	-0.27	-0.81	-0.24	-0.72	-0.50	0.30
103	0.21	-0.12	-0.37	-0.42	-0.84	0.14	-0.15	-0.61	-0.11	-0.60	-0.29	0.34
104	0.16	-0.47	-0.47	-0.71	-1.04	-0.29	-0.39	-0.95	-0.33	-0.84	-0.54	0.36
105	-0.03	-0.67	0.13	-0.87	-1.20	-0.32	-0.44	-1.17	-0.37	-0.75	-0.57	0.44
106	0.00	-0.62	-0.52	-0.49	-1.04	-0.16	-0.45	-0.89	-0.23	-0.68	-0.51	0.32
107	-0.04	-0.72	0.09	-0.82	-0.96	-0.09	-0.54	-0.68	-0.36	-0.70	-0.48	0.36
108	-0.09	-0.71	-0.60	-0.83	-1.04	-0.25	-0.19	-0.83	-0.40	-0.85	-0.58	0.33
109	-0.03	-0.78	0.05	-1.10	-1.24	-0.41	-0.56	-1.09	-0.39	-0.99	-0.65	0.46
110	-0.12	-1.22	-2.09	-0.98	-2.68	-0.26	-0.84	-1.37	-0.23	-2.53	-1.23	0.94
111	-0.47	-1.33	-0.67	-1.31	-1.57	-0.53	-0.84	-1.70	-0.49	-2.82	-1.17	0.74
112	0.13	-0.91	-0.84	-1.10	-1.55	-0.41	-0.66	-1.51	-0.50	-1.10	-0.85	0.51
113	0.16	-1.17	-0.81	-0.99	-1.42	-0.35	-0.61	-1.18	-0.42	-0.83	-0.76	0.47
114	-0.03	-0.16	-0.44	-0.55	-0.86	-0.45	-0.60	-0.79	-0.12	-0.95	-0.49	0.32
115	-0.09	-0.60	-0.54	-0.86	-1.88	-0.19	-0.63	-1.03	-0.23	-1.38	-0.74	0.56
116	-0.14	-0.51	-0.61	-0.90	-1.20	-0.19	-0.52	-1.15	-0.40	-0.87	-0.65	0.37
117	0.05	-0.79	0.22	-0.88	-1.22	-0.46	-0.32	-1.27	-0.34	-1.06	-0.61	0.52
118	-0.18	-1.04	-1.14	-1.23	-1.86	-0.43	-1.16	-1.42	-0.48	-1.12	-1.01	0.50
119	-0.24	-1.04	-1.03	-1.38	-1.94	-0.43	-0.95	-1.64	-0.48	-1.65	-1.08	0.58

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
120	0.03	-0.86	-0.77	-0.94	-1.37	-0.19	-0.48	-1.09	-0.35	-1.02	-0.70	0.44
121	-0.49	-1.12	-0.85	-1.07	-1.76	-0.64	-0.76	-1.57	-0.63	-1.36	-1.02	0.43
122	-0.16	-0.90	-0.50	-1.22	-1.98	-0.43	-0.69	-1.46	-0.49	-1.40	-0.92	0.57
123	-0.26	-0.89	-0.67	-1.06	-1.70	-0.28	-0.62	-1.34	-0.43	-1.11	-0.83	0.47
124	0.15	-1.03	-0.21	-1.48	-1.32	-0.44	-0.60	-1.57	-0.48	-1.05	-0.80	0.57
125	-0.15	-0.86	-0.89	-0.96	-1.87	-0.21	-0.53	-1.15	-0.34	-1.16	-0.81	0.53
126	-0.14	-1.03	-0.80	-1.47	-2.17	-0.56	-1.00	-1.69	-0.52	-1.56	-1.10	0.62
127	0.57	-0.75	-0.04	-0.52	-1.14	0.37	-0.13	-0.60	0.30	-0.78	-0.27	0.57
128	-0.20	-0.98	-0.66	-1.38	-1.82	-0.49	-0.63	-1.47	-0.48	-1.16	-0.93	0.52
129	-0.05	-0.87	-0.23	-1.23	-1.48	-0.53	-0.74	-1.48	-0.39	-1.11	-0.81	0.51
130	0.19	-1.18	-0.01	-1.64	-2.16	-0.70	-1.08	-1.90	-0.51	-1.51	-1.05	0.79
131	0.03	-0.77	-0.93	-1.44	-1.49	-0.56	-0.63	-1.36	-0.53	-1.43	-0.91	0.51
132	0.01	-0.71	0.44	-0.50	-0.64	-0.45	-0.45	-1.33	-0.47	-1.12	-0.52	0.50
133	0.03	-0.63	1.36	-1.26	-0.32	-0.34	-1.00	-1.30	-0.31	-1.65	-0.54	0.86
134	-0.12	-0.44	1.22	-0.73	0.39	-0.13	-0.51	-1.14	-0.21	-1.24	-0.29	0.72
135	-0.05	-0.27	2.25	-0.65	0.20	0.17	-0.50	-1.28	-0.32	0.32	-0.01	0.93
136	0.34	-0.09	2.62	-0.22	0.05	0.91	0.01	-0.73	0.27	1.21	0.44	0.94
137	0.38	-0.29	0.36	-0.32	-1.36	0.89	-0.24	-0.25	0.34	-0.62	-0.11	0.63
138	0.34	-0.10	-0.05	-0.87	-1.21	0.36	-0.56	-0.92	-0.28	-0.78	-0.41	0.54
139	0.10	-0.56	-0.59	-1.17	-1.63	-0.08	-0.75	-1.36	-0.45	-1.16	-0.76	0.56
140	0.81	0.52	2.14	0.98	0.62	0.91	0.60	0.44	0.55	1.18	0.88	0.50
141	0.08	-1.02	-0.17	-1.06	-0.51	-0.38	-0.31	-1.00	-0.50	-1.19	-0.61	0.43
142	-0.19	-0.81	-0.56	-1.50	-2.01	-0.82	-1.31	-1.71	-0.46	-1.93	-1.13	0.65
143	-0.04	-0.53	0.13	-0.72	-1.40	-0.40	-0.59	-1.52	-0.58	-0.14	-0.58	0.54
144	-0.27	-0.80	-1.54	-1.21	-2.24	-0.41	-1.15	-1.36	-0.33	-1.66	-1.10	0.64
145	0.36	-0.70	-0.73	-0.51	-1.18	0.50	-0.04	-0.18	0.32	-0.51	-0.27	0.55
146	-0.02	-0.59	0.48	-0.72	-1.91	0.70	-0.39	-0.59	0.23	-0.96	-0.38	0.77
147	0.35	-0.41	0.96	0.26	-0.66	1.00	0.19	0.19	0.36	-0.37	0.19	0.55
148	-0.33	-0.87	-0.12	-1.18	-2.07	-0.50	-0.89	-1.09	-0.58	-1.65	-0.93	0.60
149	0.07	-0.33	0.03	-0.47	-0.87	-0.05	0.19	-0.90	0.02	0.35	-0.19	0.43
150	-0.35	-0.87	-0.61	-1.15	-2.34	0.00	-0.88	-1.45	-0.50	-1.51	-0.97	0.68
151	-0.14	-0.53	-0.92	-0.49	-0.97	-0.36	-0.14	-0.61	-0.50	-1.43	-0.61	0.40
152	-0.08	-0.47	0.05	-0.37	-1.21	-0.15	0.03	-0.92	-0.01	-1.01	-0.42	0.47
153	0.05	-0.05	0.39	-0.06	-1.11	0.85	-0.26	-0.53	0.32	0.74	0.03	0.59
154	0.09	-0.42	2.65	0.02	0.92	0.92	0.09	-0.37	0.30	-0.47	0.37	0.94
155	0.14	-0.02	2.87	0.42	1.41	1.22	0.31	-0.05	0.49	1.58	0.84	0.93
156	0.10	-0.20	0.42	-0.04	-0.52	1.02	-0.19	-0.26	0.43	-0.48	0.03	0.48
157	0.08	-0.10	0.59	0.24	-0.03	1.06	-0.22	-0.15	0.45	-0.20	0.17	0.42
158	0.47	0.21	2.19	1.03	0.99	1.17	0.76	0.30	0.65	0.63	0.84	0.57
159	0.18	0.43	1.14	-0.37	-1.17	-0.02	-0.29	-0.08	0.19	-0.85	-0.08	0.65

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
160	0.32	0.37	3.01	1.37	1.10	0.29	1.15	-0.04	0.30	1.30	0.92	0.89
161	0.27	0.44	2.62	0.67	-0.04	0.62	0.89	0.48	0.33	1.33	0.76	0.75
162	-0.06	-0.04	1.62	-0.79	0.35	-0.11	-0.17	-1.26	-0.44	-0.55	-0.15	0.77
163	-0.76	-0.38	0.24	-0.51	0.54	-0.31	-0.04	-1.10	-0.46	-0.44	-0.32	0.47
164	-0.09	-0.16	0.34	-0.51	0.69	-0.08	0.12	-0.43	-0.23	0.24	-0.01	0.36
165	0.02	-0.36	-0.15	-0.41	-0.45	-0.13	-0.18	-0.42	-0.24	-0.41	-0.27	0.16
166	-0.16	0.20	0.46	-0.61	-0.22	0.07	-0.21	-0.47	-0.11	-0.13	-0.12	0.31
167	0.21	0.87	1.27	0.64	-0.27	1.23	0.38	0.33	0.69	0.32	0.57	0.48
168	0.26	0.38	0.90	0.15	0.11	1.21	0.43	0.04	0.52	-0.05	0.39	0.40
169	0.11	0.83	0.94	0.60	0.44	1.46	0.57	0.38	0.66	0.53	0.65	0.37
170	-0.16	0.36	2.85	-0.22	1.26	0.42	0.03	-0.68	0.07	-0.57	0.33	1.04
171	-0.25	-0.49	1.51	-0.41	1.32	-0.21	0.02	-1.29	-0.28	-0.75	-0.08	0.87
172	-0.22	-0.36	1.89	-0.43	2.58	-0.16	0.53	-0.29	-0.22	-0.06	0.33	1.05
173	-0.06	0.05	2.38	-0.62	0.74	0.00	-0.04	-0.88	-0.20	-0.43	0.09	0.92
174	-0.27	0.77	0.55	0.06	-0.66	0.58	-0.02	-0.26	0.20	-0.38	0.06	0.47
175	0.45	1.31	2.09	2.06	0.68	1.69	1.07	1.39	1.07	1.89	1.37	0.57
176	0.07	0.55	0.05	0.50	-0.80	1.36	0.21	0.25	0.49	-0.34	0.23	0.57
177	-0.09	0.59	0.26	-0.01	-0.40	1.21	-0.24	0.53	0.46	0.08	0.24	0.47
178	-0.24	0.48	-0.49	-0.14	-1.62	0.86	-0.25	0.21	0.31	-0.66	-0.15	0.69
179	-0.16	-0.01	-0.74	-0.40	-1.99	0.66	-0.43	0.12	0.30	-0.86	-0.35	0.74
180	-0.07	0.69	2.36	0.55	1.12	1.18	0.83	0.26	0.50	1.15	0.86	0.66
181	-0.21	0.32	-0.12	0.36	-0.64	0.65	0.27	0.06	0.50	-0.27	0.09	0.40
182	-0.33	-0.33	-0.38	-0.83	0.38	-0.34	-0.19	-0.79	-0.46	-0.79	-0.41	0.36
183	-0.11	0.18	1.82	-0.41	0.20	0.69	0.03	-0.19	0.29	-1.05	0.15	0.75
184	-0.73	-0.50	-0.43	-0.16	-0.42	-0.19	-0.47	-0.89	-0.55	-1.27	-0.56	0.33
185	-0.09	0.71	1.68	-0.26	-0.46	0.56	-0.07	-0.07	0.00	-0.51	0.15	0.67
186	0.21	1.23	1.46	0.81	-0.25	0.92	0.26	0.66	1.08	0.01	0.64	0.56
187	-0.81	0.44	-0.37	-0.65	0.24	-0.08	-0.32	-0.89	-0.38	-0.11	-0.29	0.43
188	-0.43	0.61	1.53	-0.27	1.03	0.05	0.09	-0.05	-0.10	-0.71	0.18	0.69
189	-0.34	0.26	1.03	-0.56	0.69	-0.31	-0.11	-0.67	-0.41	-0.56	-0.10	0.58
190	0.02	0.94	1.43	0.85	0.85	0.29	0.95	0.69	1.02	-0.26	0.68	0.51
191	-0.13	0.48	1.58	0.90	1.45	0.31	0.97	0.55	0.50	0.16	0.68	0.55
192	-0.40	-0.14	-1.12	-0.41	-0.43	-0.36	-0.23	-0.34	0.01	-0.37	-0.38	0.30
193	-0.69	0.01	-2.22	0.04	0.25	-0.04	0.24	-0.04	-0.16	1.43	-0.12	0.91
194	-0.62	-0.29	-1.00	-0.46	-0.18	-0.11	-0.11	-0.47	-0.26	-0.28	-0.38	0.27
195	-0.53	-0.67	-0.42	-0.32	-0.29	-0.12	-0.13	-0.13	-0.17	-0.53	-0.33	0.20
196	-0.27	0.49	-0.59	0.59	0.56	-0.02	0.10	0.75	0.51	0.06	0.22	0.43
197	-0.14	0.02	-0.43	0.35	0.35	-0.14	0.16	-0.26	0.22	-0.27	-0.01	0.27
198	0.01	-0.18	0.45	-0.02	1.42	0.12	0.07	0.19	0.06	0.07	0.22	0.45
199	-0.45	0.04	-2.00	0.14	0.07	-0.11	-0.10	0.01	0.11	-0.05	-0.23	0.64

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
200	-0.69	-0.83	-4.68	-0.70	0.01	-1.06	-0.20	-0.28	-0.20	-1.53	-1.02	1.37
201	-1.22	-1.72	-3.46	-1.00	-0.82	-1.17	-0.88	-0.63	-1.38	-0.85	-1.31	0.82
202	-0.05	-0.38	-1.38	-0.22	-0.27	0.07	-0.52	-0.13	0.01	0.05	-0.28	0.43
203	-0.06	-0.28	-1.40	0.04	0.83	-0.23	-0.01	0.35	0.15	0.29	-0.03	0.58
204	0.13	0.12	-1.35	0.11	0.40	-0.25	-0.14	0.58	0.22	0.52	0.03	0.55
205	0.18	0.46	-0.97	0.21	0.81	-0.10	0.05	0.97	0.39	0.63	0.26	0.55
206	-0.40	-0.32	-3.46	-0.41	-1.51	-0.03	-0.29	0.72	0.37	0.65	-0.47	1.23
207	-0.91	-2.11	-2.71	-1.16	-0.59	-0.86	-0.42	-1.20	-1.05	-0.37	-1.14	0.74
208	-0.14	0.28	-1.09	0.37	0.10	0.29	0.23	0.42	0.33	-1.04	-0.02	0.57
209	-0.15	0.48	-0.74	0.14	0.48	-0.40	0.13	0.28	0.32	-0.98	-0.04	0.51
210	-1.24	-0.76	-1.84	-1.20	-0.31	-0.39	-0.61	-0.30	-0.55	0.16	-0.70	0.58
211	-0.88	-0.79	-3.71	0.26	-0.36	-0.70	0.07	0.55	0.16	0.31	-0.51	1.23
212	-0.31	0.30	-1.79	1.31	0.93	-0.02	0.85	1.55	0.73	-0.02	0.35	0.96
213	-0.35	-0.75	-2.85	0.49	-0.29	-0.57	0.15	0.76	0.19	0.79	-0.24	1.06
214	-0.70	-0.53	-2.05	-0.65	0.69	-0.79	-0.21	-0.31	-0.66	0.25	-0.50	0.72
215	-0.68	-0.92	-2.72	-1.37	-0.50	-0.92	-0.80	-0.47	-0.55	0.09	-0.88	0.75
216	-0.61	-0.48	-0.72	0.84	1.32	-0.19	0.40	1.29	0.59	-0.31	0.21	0.78
217	-0.80	-0.96	-2.73	-0.44	0.05	-1.35	-0.16	-0.50	-0.97	-0.09	-0.79	0.81
218	0.04	-0.09	-0.98	0.53	1.12	0.51	0.56	1.18	0.41	1.90	0.52	0.79
219	-0.53	-0.40	-1.51	0.65	2.04	-0.32	0.49	1.02	0.13	0.37	0.19	0.97
220	0.37	-0.19	-0.38	-0.89	0.29	-0.58	-0.01	-0.08	-0.16	1.01	-0.06	0.53
221	-0.22	0.28	-0.27	1.36	1.10	0.01	0.71	1.14	0.39	1.63	0.61	0.68
222	-0.85	-0.88	-2.12	0.06	0.85	-1.43	0.24	0.13	-0.49	0.66	-0.38	0.95
223	-0.11	-0.12	-0.57	1.03	0.77	-0.88	0.28	0.58	0.17	-0.12	0.10	0.59
224	-0.39	0.50	0.19	3.07	2.19	1.36	1.46	2.39	0.77	2.74	1.43	1.16
225	-0.52	-0.40	-1.44	-0.20	-0.62	-0.46	-0.58	0.22	-0.02	1.02	-0.30	0.64
226	0.24	0.46	0.44	2.21	1.68	1.05	1.10	2.34	0.50	2.28	1.23	0.84
227	-0.65	0.37	-1.23	1.89	-0.07	1.12	0.68	1.01	0.37	2.06	0.55	1.04
228	-0.46	0.55	-0.48	1.65	0.03	1.13	0.58	1.01	0.55	1.53	0.61	0.75
229	0.27	0.15	-0.16	0.84	0.93	-0.07	0.94	0.75	0.91	1.31	0.59	0.50
230	-0.09	-0.30	-2.09	0.40	-0.24	-0.79	0.72	-0.27	-0.41	1.32	-0.17	0.91
231	-0.36	-0.79	-0.33	0.33	-0.19	-0.89	0.35	-0.78	-0.45	1.26	-0.19	0.66
232	-0.20	0.40	0.47	0.41	0.23	-0.64	0.61	-0.37	0.25	1.39	0.26	0.57
233	0.23	0.48	0.54	0.60	-0.71	0.47	0.74	0.43	0.74	1.77	0.53	0.60
234	-0.03	0.61	-1.62	0.35	-1.75	-0.06	0.20	0.10	0.86	1.47	0.01	1.01
235	-0.32	-0.34	-2.26	-1.02	-1.88	-0.61	-0.93	-0.89	0.13	0.55	-0.76	0.85
236	0.14	-0.61	-1.87	0.80	-0.81	1.07	1.14	0.54	0.69	0.33	0.14	0.96

(Sheet 6 of 6)

Table D2. Northern longshore transport rates, change = P1 – Ex, 1990–1999, 1,000 cu yd/yr.

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
1	1.37	1.61	1.86	2.47	2.34	2.05	2.71	1.01	3.10	5.18	2.37	1.17
2	0.36	-0.06	1.63	0.66	1.62	1.98	0.18	0.13	0.58	3.85	1.09	1.20
3	0.27	0.41	0.25	0.61	0.95	-0.33	0.98	0.30	-0.19	0.21	0.35	0.42
4	0.17	0.02	-0.26	-0.07	-0.20	-0.10	0.15	-0.19	0.15	0.10	-0.02	0.16
5	0.30	2.46	3.62	1.33	1.42	1.90	0.75	1.20	1.06	1.14	1.52	0.94
6	-0.01	1.27	3.54	0.62	1.19	1.74	0.43	0.83	-0.10	0.62	1.01	1.05
7	0.42	1.86	2.11	2.12	1.19	1.80	0.37	1.28	2.10	0.96	1.42	0.68
8	0.32	0.93	0.45	0.98	0.48	0.38	0.09	0.80	0.84	1.16	0.64	0.35
9	0.64	1.23	1.18	1.87	1.18	1.69	0.76	0.86	1.35	0.65	1.14	0.42
10	0.13	-0.06	0.96	0.67	1.02	0.76	0.44	0.58	1.02	1.19	0.67	0.41
11	0.43	1.20	3.40	1.35	0.74	2.46	1.82	0.62	1.31	0.97	1.43	0.91
12	1.28	2.39	4.20	3.29	2.14	2.48	3.48	1.36	2.01	4.57	2.72	1.13
13	0.52	1.01	0.85	2.23	0.75	1.07	1.23	1.00	2.42	1.21	1.23	0.62
14	0.64	1.56	4.93	2.10	1.43	3.40	0.51	1.15	1.42	2.12	1.93	1.34
15	0.99	3.12	4.48	1.23	2.33	0.51	1.52	0.72	2.69	2.68	2.03	1.25
16	0.37	0.57	3.59	1.98	1.51	2.82	1.66	1.16	1.85	0.90	1.64	1.00
17	0.71	2.59	5.07	2.81	2.53	1.39	1.88	0.94	3.52	4.55	2.60	1.46
18	0.28	0.34	1.61	0.48	0.99	0.76	0.15	0.59	0.02	1.04	0.62	0.48
19	-0.08	2.23	4.23	0.79	1.29	0.81	0.62	0.44	0.49	1.18	1.20	1.23
20	1.80	1.71	3.97	1.96	1.74	1.52	1.70	1.87	1.78	2.33	2.04	0.71
21	1.41	2.82	2.30	3.50	1.18	3.12	4.35	1.41	4.19	5.18	2.95	1.38
22	0.69	1.57	2.70	2.04	2.37	2.70	1.37	0.93	2.62	2.21	1.92	0.74
23	0.57	0.29	0.17	1.57	0.62	1.01	0.56	1.00	1.92	1.69	0.94	0.61
24	0.66	3.48	5.70	1.96	2.18	1.64	2.50	0.72	2.36	2.13	2.33	1.44
25	1.08	1.72	4.00	2.04	1.67	3.36	3.40	1.53	3.21	3.59	2.56	1.05
26	0.22	0.82	1.98	1.16	1.15	0.77	1.06	0.50	0.68	0.96	0.93	0.47
27	1.04	4.10	7.74	2.27	1.58	3.87	2.11	1.52	4.13	3.15	3.15	1.97
28	0.48	0.71	1.03	2.33	1.01	1.36	1.67	0.78	1.99	1.98	1.33	0.63
29	0.41	0.30	2.78	1.67	1.83	2.22	0.50	0.16	0.53	0.79	1.12	0.93
30	1.41	2.15	2.53	2.63	2.49	3.06	3.00	1.23	4.28	4.21	2.70	1.01
31	2.76	4.44	6.02	5.58	4.13	4.54	5.73	1.85	5.78	8.65	4.95	1.89
32	0.06	0.08	2.18	1.41	0.88	2.20	0.50	0.59	1.97	1.32	1.12	0.82
33	2.83	4.39	7.48	3.81	4.16	2.38	3.86	1.89	5.27	4.72	4.08	1.59
34	1.91	4.53	6.54	3.74	3.30	2.58	4.11	2.34	4.32	4.13	3.75	1.33
35	-0.18	0.06	0.77	0.51	0.47	1.02	0.26	0.42	0.01	0.86	0.42	0.39
36	0.27	0.57	0.83	1.65	0.99	1.94	0.60	0.84	2.38	0.80	1.08	0.68
37	0.29	0.92	3.21	1.57	1.62	1.61	1.01	0.73	2.23	1.52	1.47	0.82
38	1.22	1.75	2.07	4.01	1.52	2.46	3.36	1.61	3.28	4.49	2.58	1.14
39	1.35	4.36	6.43	2.22	3.72	4.37	2.60	1.74	3.76	7.41	3.80	1.96

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
40	-0.26	-0.25	1.21	0.58	0.42	0.42	0.14	-0.18	0.43	0.28	0.28	0.45
41	0.88	2.70	1.40	2.44	1.13	2.36	1.55	0.93	3.20	3.10	1.97	0.89
42	0.60	2.57	4.22	1.96	2.73	2.22	1.85	0.86	3.75	4.94	2.57	1.40
43	0.24	1.00	2.50	1.54	1.21	2.48	1.65	0.27	0.45	4.16	1.55	1.23
44	0.48	3.27	4.88	2.30	2.83	2.18	1.90	1.77	2.14	2.57	2.43	1.13
45	0.95	4.07	5.31	2.33	3.29	2.25	2.42	1.79	2.13	4.89	2.94	1.41
46	-0.94	-0.79	1.24	-0.20	-0.34	1.18	-0.84	-0.08	-0.43	0.96	-0.02	0.84
47	1.55	2.45	5.20	4.92	2.98	5.81	4.85	2.12	4.06	7.43	4.14	1.85
48	0.30	2.99	4.37	1.49	1.13	0.48	1.26	0.68	2.08	2.07	1.69	1.25
49	2.51	4.95	9.36	4.98	6.55	6.74	4.43	2.50	7.23	9.56	5.88	2.48
50	0.72	3.25	5.48	2.67	1.76	3.42	1.95	1.99	2.99	2.86	2.71	1.27
51	2.05	2.56	3.42	3.79	2.96	3.50	4.00	2.38	5.29	8.05	3.80	1.76
52	0.71	0.85	1.17	2.46	1.36	1.88	1.15	0.49	2.70	3.44	1.62	0.97
53	0.35	1.64	2.31	1.21	3.01	1.71	0.93	0.85	2.72	2.26	1.70	0.87
54	0.54	1.41	1.69	2.72	1.84	3.69	2.29	0.60	2.16	6.65	2.36	1.78
55	1.14	2.10	2.96	3.09	2.59	5.24	4.38	1.15	2.58	7.95	3.32	2.07
56	1.82	4.03	7.16	4.19	3.55	3.86	6.09	1.48	3.99	8.88	4.51	2.28
57	-0.27	1.85	4.01	0.49	0.59	-0.52	0.64	-0.13	1.59	1.70	0.99	1.35
58	1.98	4.72	6.95	4.26	4.85	4.50	5.27	1.54	5.58	9.01	4.87	2.16
59	1.09	1.90	5.51	3.09	2.18	3.47	0.83	1.77	1.19	0.89	2.19	1.47
60	-1.09	-1.04	0.42	-0.73	-1.31	0.75	-1.57	-0.23	-1.37	-1.51	-0.77	0.82
61	1.48	1.80	3.38	3.05	2.27	4.10	2.51	1.30	2.48	1.02	2.34	0.98
62	0.29	1.29	3.30	1.19	0.21	1.66	0.53	-0.14	0.74	1.86	1.09	1.01
63	-0.08	0.64	0.20	1.59	0.70	2.28	0.04	0.20	1.26	-0.04	0.68	0.80
64	-0.02	1.47	2.18	1.13	-0.15	1.83	0.27	0.21	0.41	1.19	0.85	0.82
65	2.45	4.22	8.45	4.84	4.58	5.12	6.09	2.01	6.72	10.52	5.50	2.59
66	3.59	5.43	8.80	5.07	5.74	5.45	6.50	2.75	6.20	9.84	5.94	2.13
67	1.13	3.94	5.00	4.10	2.51	2.28	2.74	1.14	3.39	4.93	3.11	1.40
68	-1.29	0.15	0.15	-0.94	-0.97	-0.48	-1.76	-0.13	-1.46	-1.20	-0.79	0.68
69	-0.71	0.64	-1.36	0.52	-0.25	0.46	-1.21	0.04	0.64	-0.78	-0.20	0.77
70	-1.31	0.58	-0.31	0.18	-1.26	-0.03	-1.14	-0.74	0.43	-0.42	-0.40	0.70
71	2.62	4.95	7.25	3.28	5.14	4.29	4.97	1.61	5.84	9.06	4.90	2.18
72	1.00	4.40	10.99	3.32	5.36	3.80	3.89	1.52	4.21	4.80	4.33	2.71
73	2.32	4.89	8.24	3.19	4.79	2.61	4.32	2.81	3.82	6.43	4.34	1.86
74	-0.23	1.33	-0.12	1.48	0.19	0.73	1.20	0.08	1.82	4.84	1.13	1.49
75	1.47	3.24	9.37	2.50	4.50	4.08	3.00	1.00	4.44	5.38	3.90	2.37
76	0.13	3.99	9.06	2.28	5.19	3.79	1.52	0.84	2.72	6.52	3.60	2.74
77	-0.79	-0.32	-0.72	0.63	-0.58	1.34	-1.06	-0.07	0.16	-0.19	-0.16	0.72
78	0.14	4.35	2.39	2.55	1.42	1.01	2.08	1.37	2.70	5.89	2.39	1.67
79	1.08	4.10	2.95	3.97	1.31	2.83	3.90	0.94	1.40	3.83	2.63	1.32



Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
80	-1.10	-0.27	-0.04	0.64	0.69	-0.17	-0.48	-0.16	1.23	1.47	0.18	0.80
81	0.50	3.27	3.12	2.43	2.02	-0.67	2.50	-0.21	2.83	1.91	1.77	1.40
82	-0.22	3.28	3.16	0.09	0.36	0.95	0.59	0.84	1.90	0.59	1.15	1.23
83	0.28	2.93	2.19	2.02	2.26	1.13	2.11	-0.26	3.37	3.60	1.96	1.26
84	-0.50	0.45	-0.40	0.33	-1.70	-0.22	0.03	-0.37	-0.33	0.13	-0.26	0.60
85	0.28	-0.06	-1.38	1.39	0.92	-0.59	0.02	-0.06	2.02	1.48	0.40	1.04
86	0.35	1.19	-0.69	1.58	0.03	0.61	2.89	0.31	1.32	3.49	1.11	1.29
87	1.51	1.81	7.85	2.89	4.38	4.20	2.49	1.43	5.32	6.12	3.80	2.16
88	0.04	3.56	6.64	1.23	1.97	2.54	1.03	1.04	2.57	4.43	2.50	1.95
89	-0.40	3.48	7.88	1.66	4.29	2.67	0.76	0.44	2.96	6.49	3.02	2.65
90	0.58	4.54	8.48	2.15	5.78	2.19	2.81	1.57	4.36	7.43	3.99	2.61
91	-0.41	2.80	4.23	0.82	2.75	-1.01	1.35	0.09	2.80	2.27	1.57	1.68
92	1.88	1.61	2.09	2.75	3.94	2.95	3.35	0.43	3.02	5.20	2.72	1.32
93	0.65	0.23	-0.12	1.44	0.33	0.64	2.32	-0.21	1.75	2.46	0.95	0.98
94	0.32	0.36	-0.15	0.67	-0.35	0.32	2.28	-0.04	1.67	3.34	0.84	1.20
95	-0.21	1.55	1.76	1.72	-0.24	2.10	0.98	0.63	2.38	2.77	1.34	1.03
96	-0.09	2.56	5.39	1.59	3.93	2.32	1.12	0.36	3.00	5.17	2.54	1.88
97	-0.89	1.87	1.17	0.16	1.33	0.65	-0.39	0.03	2.02	3.74	0.97	1.36
98	-1.00	0.01	-0.23	-0.19	1.02	2.32	-0.67	-0.70	1.28	4.19	0.60	1.63
99	-1.98	0.25	-0.30	-1.25	-2.32	0.04	-2.49	-1.01	-0.13	-1.74	-1.09	1.02
100	-1.46	-0.02	-1.13	-0.74	-1.85	-1.09	-1.69	-0.37	-0.92	-1.46	-1.07	0.58
101	-1.00	0.20	1.94	-0.36	1.46	-0.16	-1.42	-0.50	1.03	2.80	0.40	1.36
102	-0.82	0.31	1.32	0.25	1.36	-0.31	-1.24	-0.57	0.60	0.92	0.18	0.90
103	-0.84	1.79	2.67	0.41	2.07	0.55	-0.57	-0.62	0.81	1.85	0.81	1.25
104	-0.26	1.49	3.39	1.90	3.46	1.67	0.69	-0.13	2.01	3.46	1.77	1.39
105	0.09	2.22	3.07	0.65	1.91	-0.61	-0.38	0.31	3.42	2.95	1.36	1.52
106	0.15	-0.07	-0.79	0.63	0.70	1.10	1.04	-0.05	0.30	4.29	0.73	1.37
107	-0.42	3.08	5.53	0.77	1.56	-2.06	-0.53	0.24	3.68	0.14	1.20	2.29
108	-1.16	-0.65	0.35	0.84	2.67	0.70	-0.84	-0.94	-0.39	3.64	0.42	1.61
109	0.11	0.50	1.79	0.32	3.18	0.07	0.29	0.29	3.27	5.68	1.55	1.91
110	-1.83	-0.83	-0.07	-1.53	1.30	-0.70	-2.11	-1.23	-0.31	3.13	-0.42	1.59
111	0.46	0.26	0.45	-0.18	-0.07	-0.18	0.92	-0.11	1.73	4.53	0.78	1.44
112	-0.95	-1.20	-2.38	-0.69	-1.11	-1.32	-2.72	-1.06	-1.52	0.91	-1.20	0.98
113	-2.27	1.00	0.04	-1.51	-0.28	-2.46	-2.63	-1.09	-1.28	0.21	-1.03	1.24
114	-2.44	0.17	-0.66	-2.20	0.19	-3.53	-2.86	-1.01	-2.09	0.54	-1.39	1.43
115	-2.25	-1.54	-2.72	-1.90	0.07	-0.50	-2.83	-1.10	-0.86	2.22	-1.14	1.51
116	-1.89	1.43	2.64	-1.02	2.44	-2.33	-1.61	-0.94	1.47	3.91	0.41	2.22
117	-1.33	-0.69	1.15	0.55	2.88	0.35	-1.39	-1.06	0.84	4.26	0.56	1.86
118	-0.43	-0.68	0.49	0.69	1.99	0.41	-1.76	-0.58	0.99	2.90	0.40	1.36
119	-1.66	0.97	1.29	-0.38	1.06	-2.54	-0.59	-1.13	0.84	2.14	0.00	1.49

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
120	-1.40	-0.73	-0.79	-1.00	-0.03	-2.29	-2.38	-0.66	-0.86	-0.13	-1.03	0.79
121	-1.44	-0.75	-1.05	-0.60	-0.57	-3.54	-2.31	-1.01	-1.68	-2.91	-1.59	1.02
122	-2.61	-0.91	-2.76	-3.52	-3.74	-5.90	-4.87	-1.36	-3.66	-4.90	-3.42	1.57
123	-2.00	-1.31	-4.24	-2.36	-3.25	-5.77	-4.09	-1.47	-3.17	-3.50	-3.11	1.38
124	-1.81	-1.25	-2.86	-3.23	-0.38	-2.77	-3.15	-1.10	-2.63	1.16	-1.80	1.42
125	-1.66	-0.39	-0.90	-2.52	1.11	-2.02	-2.86	-1.23	-0.90	1.38	-1.00	1.41
126	-0.75	-0.73	-1.05	-0.65	-0.32	-2.67	-2.08	-1.02	-1.84	-1.26	-1.24	0.74
127	-3.20	-1.23	-3.07	-2.03	-1.47	-5.04	-3.71	-1.46	-3.26	-1.46	-2.59	1.26
128	-2.02	-0.83	-0.73	-1.92	0.55	-2.83	-1.94	-1.45	-1.95	0.11	-1.30	1.06
129	-2.32	-0.22	-2.27	-1.91	-1.61	-4.58	-3.52	-1.37	-2.50	-2.65	-2.30	1.19
130	-3.07	-1.17	-3.45	-3.19	-3.68	-6.69	-5.63	-2.18	-4.14	-6.40	-3.96	1.79
131	-3.15	-2.69	-4.18	-4.05	-2.50	-6.41	-6.55	-1.96	-3.35	-3.10	-3.79	1.56
132	-3.43	-1.73	-3.27	-3.24	0.12	-7.14	-6.41	-1.74	-1.90	-1.21	-3.00	2.27
133	-1.97	0.42	1.59	-1.84	-0.28	-5.51	-4.18	-1.62	-2.38	-3.97	-1.98	2.18
134	-3.07	0.39	1.34	-2.67	-1.79	-5.35	-3.45	-1.16	-1.34	-2.87	-2.00	1.94
135	-2.79	0.37	-0.55	-3.09	-0.78	-5.48	-4.47	-0.90	-1.60	-1.42	-2.07	1.85
136	-4.22	-0.31	-0.36	-3.73	-1.01	-6.55	-5.25	-1.80	-1.55	-2.34	-2.71	2.13
137	-2.88	0.56	3.20	-2.21	1.03	-5.87	-5.39	-1.48	-2.32	-1.65	-1.70	2.78
138	-3.80	0.30	0.76	-3.62	-2.16	-7.40	-5.82	-1.78	-3.71	-5.82	-3.30	2.65
139	-3.59	0.53	1.94	-2.01	0.25	-5.70	-6.13	-1.48	-3.58	-3.86	-2.36	2.69
140	-2.77	-0.03	-1.21	-1.83	0.09	-8.19	-6.08	-1.91	-3.19	-2.18	-2.73	2.59
141	-2.52	-1.38	0.72	-1.81	0.84	-5.64	-4.30	-1.77	-1.98	-2.12	-2.00	1.96
142	-3.04	0.21	-1.31	-2.99	-0.09	-5.06	-3.84	-1.69	-2.97	-0.92	-2.17	1.69
143	-1.93	-0.02	-0.43	-2.15	-0.81	-4.80	-3.88	-1.10	-1.61	-3.61	-2.04	1.59
144	-3.10	-0.39	-4.38	-4.62	-7.07	-10.51	-7.33	-1.68	-4.21	-10.79	-5.41	3.48
145	-2.91	-0.30	-2.38	-3.78	-3.47	-6.39	-5.33	-1.78	-2.00	-5.25	-3.36	1.88
146	-1.54	1.25	0.89	-1.43	-1.84	-5.96	-3.59	-0.79	-1.84	-6.33	-2.12	2.54
147	-1.74	1.42	2.11	-2.41	-2.50	-6.13	-3.97	-0.36	-2.30	-3.40	-1.93	2.46
148	-2.29	1.08	1.77	-2.82	-2.15	-5.09	-4.08	-0.95	-2.49	-3.74	-2.08	2.18
149	-3.14	0.13	-2.66	-3.53	-4.81	-7.93	-6.46	-1.62	-3.22	-7.33	-4.06	2.57
150	-2.80	-0.19	-1.27	-2.76	-4.06	-6.53	-5.29	-1.37	-3.42	-6.47	-3.42	2.18
151	-2.61	1.69	1.33	-2.37	-1.45	-3.59	-4.61	-1.36	-2.31	-1.13	-1.64	1.97
152	-2.81	2.17	1.87	-3.48	-3.70	-6.93	-4.92	-1.15	-1.38	-5.54	-2.59	3.00
153	-2.03	0.25	0.09	-3.29	-1.45	-4.50	-4.73	-1.44	-2.19	-2.27	-2.16	1.68
154	-2.52	1.53	2.42	-1.82	-0.93	-5.77	-3.81	-0.83	-0.07	-3.36	-1.52	2.49
155	-2.84	1.58	3.20	-1.60	-1.55	-4.25	-3.91	-1.06	-0.14	-5.89	-1.65	2.75
156	-1.18	3.44	5.24	-0.52	-0.75	-1.74	-2.52	-0.36	-0.42	-3.03	-0.18	2.58
157	-1.57	4.56	5.74	-0.34	0.19	-2.17	-2.96	-0.56	0.21	-2.07	0.10	2.87
158	-1.23	3.69	4.64	-0.81	0.21	-2.62	-2.85	-0.59	-0.32	0.16	0.03	2.42
159	-1.54	2.11	2.15	-1.52	-1.13	-2.65	-2.63	-0.07	-0.20	-1.27	-0.67	1.70

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
160	-1.22	2.70	3.42	-1.69	-0.52	-0.93	-2.43	-0.06	0.06	-0.71	-0.14	1.85
161	-2.40	4.49	7.38	-0.83	0.95	-0.49	-2.30	0.08	-0.49	0.59	0.70	3.04
162	-1.50	3.77	4.56	-1.64	-0.15	-0.57	-2.17	-0.95	-0.17	0.31	0.15	2.26
163	-1.58	3.58	6.78	-0.75	0.10	-1.91	-2.06	-0.50	1.84	-0.14	0.54	2.80
164	-1.28	2.87	7.84	-0.65	0.95	-0.98	-2.54	-0.59	1.44	-0.15	0.69	2.94
165	-1.07	3.25	5.20	-0.10	3.03	-0.61	-1.41	-1.34	1.99	3.51	1.25	2.42
166	0.23	4.32	8.69	0.16	4.08	-0.75	-0.31	0.19	2.54	3.38	2.25	2.96
167	0.15	4.81	9.96	1.69	4.74	2.58	1.87	0.17	4.21	5.50	3.57	2.95
168	0.15	5.62	12.64	1.88	6.02	2.42	0.40	0.61	4.37	7.64	4.18	3.95
169	-0.08	4.66	12.34	1.81	5.76	5.06	1.74	0.72	5.44	6.81	4.43	3.65
170	-0.43	5.02	10.06	1.20	6.13	5.51	1.10	1.12	2.83	9.78	4.23	3.70
171	1.26	7.53	12.77	3.42	7.05	5.51	2.63	1.43	4.93	9.25	5.58	3.67
172	1.25	6.31	11.95	3.02	8.51	6.20	4.19	1.12	4.62	9.96	5.71	3.61
173	1.49	7.55	16.20	4.16	10.80	8.76	5.00	1.51	5.50	14.22	7.52	5.02
174	1.36	7.47	13.13	3.70	8.58	9.95	4.59	2.12	4.41	13.91	6.92	4.42
175	-0.41	6.54	10.79	3.23	7.52	7.89	3.40	0.95	2.09	13.26	5.53	4.42
176	2.53	5.64	12.02	5.18	6.28	9.11	4.38	2.02	4.72	6.74	5.86	2.97
177	3.47	5.90	13.11	6.06	7.73	12.02	6.17	2.87	5.88	8.31	7.15	3.30
178	2.49	7.31	13.49	6.42	9.57	11.49	6.63	1.98	6.90	12.71	7.90	3.94
179	4.93	9.51	18.49	9.55	12.64	15.39	10.68	3.99	10.08	16.49	11.17	4.70
180	5.34	9.14	17.09	9.47	11.99	15.93	11.10	3.86	9.11	15.96	10.90	4.46
181	4.55	7.35	14.37	8.16	10.82	15.36	10.12	2.88	8.32	16.02	9.79	4.45
182	6.00	5.71	12.46	8.46	10.00	17.10	12.54	3.82	9.56	16.69	10.24	4.50
183	4.72	7.32	15.46	7.16	10.73	17.74	10.98	3.66	9.75	17.36	10.49	5.01
184	6.39	5.61	11.93	9.46	11.03	18.19	13.04	3.92	9.14	18.03	10.67	4.85
185	6.77	5.21	13.77	11.54	13.65	24.27	14.88	4.14	11.22	20.64	12.61	6.43
186	6.86	4.95	16.06	11.18	15.96	24.10	15.67	4.14	13.31	26.81	13.90	7.57
187	8.35	6.29	16.61	9.33	12.16	21.69	14.76	5.26	10.52	19.51	12.45	5.56
188	8.26	6.07	16.14	9.64	11.38	22.95	16.33	5.36	12.53	22.32	13.10	6.23
189	6.20	5.19	13.40	8.00	8.84	19.86	13.90	3.78	10.88	17.88	10.79	5.40
190	7.36	5.67	14.35	10.88	15.26	26.27	16.73	4.87	11.25	28.05	14.07	7.97
191	6.80	4.48	15.33	11.23	18.64	26.07	15.73	4.44	12.01	31.29	14.60	8.90
192	9.16	5.28	18.51	13.23	21.90	30.54	17.89	5.61	13.08	33.95	16.91	9.75
193	9.16	5.91	20.35	15.75	21.53	30.47	20.63	5.60	16.40	33.48	17.93	9.46
194	9.78	5.34	19.82	15.63	22.77	30.87	20.14	6.39	14.28	34.37	17.94	9.70
195	9.03	6.34	18.10	14.28	21.25	29.75	21.16	5.82	14.29	32.45	17.25	9.15
196	9.69	4.66	16.93	14.85	21.25	30.66	19.71	5.77	14.17	29.80	16.75	8.94
197	8.59	3.91	16.36	12.61	19.41	26.97	17.99	5.46	13.86	30.45	15.56	8.64
198	9.26	4.93	17.42	13.04	19.15	26.68	20.85	5.74	14.29	29.87	16.12	8.34
199	8.80	4.31	14.80	11.80	17.64	24.75	18.72	5.51	14.22	27.68	14.82	7.68

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
200	9.07	4.10	14.63	12.98	19.33	22.91	18.37	5.47	13.66	31.92	15.24	8.36
201	7.92	4.54	13.95	12.46	18.33	22.36	17.05	5.63	12.91	27.55	14.27	7.31
202	8.60	3.87	12.66	12.96	17.54	24.06	17.96	5.34	12.75	28.39	14.41	7.79
203	8.94	3.14	12.18	12.45	17.62	22.47	16.89	5.19	14.05	25.57	13.85	7.10
204	9.77	3.62	11.51	13.74	16.39	23.67	18.94	5.65	13.28	26.41	14.30	7.29
205	9.71	2.31	12.20	13.34	16.85	22.42	18.03	5.37	13.45	25.76	13.94	7.20
206	8.85	3.37	12.87	12.92	17.65	21.03	16.56	5.00	12.62	26.61	13.75	7.09
207	9.64	4.65	14.01	14.21	18.71	24.78	18.74	6.17	15.40	27.03	15.33	7.32
208	9.81	3.62	14.57	14.84	18.21	26.35	19.86	6.09	15.75	26.79	15.59	7.71
209	10.12	2.63	13.47	16.48	18.27	26.59	20.18	6.15	16.49	26.98	15.74	7.97
210	11.69	4.84	17.41	19.73	21.48	30.65	23.19	7.96	20.00	30.63	18.76	8.65
211	12.71	4.70	17.13	17.56	20.64	30.44	24.19	7.52	18.71	31.77	18.54	8.84
212	12.79	4.38	14.47	18.98	22.15	30.13	25.59	7.98	18.34	33.12	18.79	9.26
213	14.39	5.46	17.33	21.31	24.51	32.57	27.44	8.45	21.16	37.13	20.98	10.02
214	14.90	4.79	18.78	22.62	24.39	33.92	26.86	8.72	20.88	36.91	21.28	10.13
215	16.49	5.81	23.06	25.48	27.18	39.68	31.15	10.19	26.51	42.13	24.77	11.63
216	18.07	7.60	24.37	27.95	30.93	43.72	35.03	11.19	29.73	44.74	27.33	12.45
217	20.06	8.67	25.68	28.91	31.86	45.23	36.58	13.24	27.42	47.18	28.48	12.53
218	20.25	9.01	26.82	29.08	33.14	46.24	38.46	12.76	29.55	50.38	29.57	13.34
219	19.67	8.96	28.09	28.44	33.23	45.45	37.43	12.42	29.80	45.81	28.93	12.50
220	20.74	9.28	29.24	30.38	35.41	47.83	39.35	13.52	30.94	52.33	30.90	13.80
221	21.36	9.66	29.25	30.58	35.75	49.06	40.47	13.58	31.56	54.32	31.56	14.28
222	24.27	11.34	31.47	31.70	34.10	51.29	42.10	15.11	33.67	48.64	32.37	13.03
223	23.63	11.40	29.41	31.14	31.67	48.90	41.86	15.02	32.01	45.58	31.06	12.24
224	20.52	9.40	24.70	28.31	28.05	43.99	37.22	12.80	28.08	39.98	27.30	11.17
225	20.79	10.29	26.59	26.93	30.11	42.06	35.08	13.46	28.64	43.87	27.78	10.98
226	20.21	9.33	25.90	25.99	30.17	41.69	35.46	13.05	28.01	44.81	27.46	11.40
227	20.51	9.81	26.00	25.55	29.34	41.54	34.94	13.52	27.21	42.67	27.11	10.79
228	21.29	10.46	26.24	26.33	27.64	41.07	36.14	13.44	28.82	38.84	27.03	10.09
229	19.69	9.47	23.91	25.96	27.49	38.15	33.59	12.34	26.70	36.70	25.40	9.56
230	18.64	8.73	23.16	24.93	26.18	37.37	32.58	12.15	25.16	36.28	24.52	9.49
231	17.69	7.94	22.65	23.99	25.26	35.04	30.71	11.19	24.63	35.20	23.43	9.16
232	17.58	8.17	24.40	23.31	24.93	34.03	30.04	11.58	24.24	33.67	23.20	8.64
233	17.38	8.10	22.48	23.01	25.22	33.46	30.02	11.11	24.51	34.10	22.94	8.72
234	18.50	8.83	22.19	22.46	24.71	33.98	29.97	11.67	24.28	35.32	23.19	8.66
235	19.83	9.50	24.04	22.81	24.45	33.68	30.77	12.42	26.41	32.95	23.69	8.08
236	18.77	9.23	22.31	21.23	23.07	32.43	30.06	11.82	25.50	31.05	22.55	7.77

(Sheet 6 of 6)

Table D3. Net longshore transport rates, change = P1 - Ex, 1990-1999, 1,000 cu yd/yr.

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
1	2.53	3.12	5.30	5.53	7.79	2.95	5.61	3.73	3.68	7.56	4.78	1.88
2	1.07	1.10	4.03	2.63	3.75	2.59	1.99	2.09	1.12	5.48	2.58	1.45
3	0.48	1.31	3.44	1.85	3.85	0.28	1.88	1.15	0.28	1.32	1.58	1.23
4	0.36	0.97	0.90	0.81	0.92	0.31	0.74	0.60	0.46	2.45	0.85	0.61
5	0.95	3.92	6.57	4.71	5.37	3.17	2.90	4.00	1.78	3.65	3.70	1.64
6	0.27	1.82	5.28	1.57	2.41	2.05	1.16	1.64	0.11	1.23	1.76	1.44
7	1.23	3.91	5.35	4.19	3.38	2.93	2.04	3.20	3.12	2.95	3.23	1.13
8	0.83	1.67	1.72	1.94	1.70	0.58	0.84	1.37	1.07	2.09	1.38	0.52
9	1.27	2.28	2.44	2.98	2.22	2.25	2.10	2.31	2.08	1.66	2.16	0.45
10	0.19	0.17	1.22	1.04	1.45	0.83	0.71	0.88	1.14	1.54	0.92	0.47
11	0.98	1.64	4.94	1.87	2.21	2.59	2.30	1.19	1.57	1.86	2.11	1.11
12	1.35	3.54	7.24	4.40	4.73	2.81	4.39	2.12	2.24	7.50	4.03	2.08
13	1.03	2.16	4.46	3.54	3.30	1.76	3.09	2.50	3.20	2.46	2.75	0.98
14	1.00	2.58	6.69	2.72	2.36	3.59	1.33	2.19	1.55	3.00	2.70	1.61
15	1.41	4.76	5.84	3.00	4.31	0.94	2.29	2.60	3.43	3.93	3.25	1.52
16	1.35	1.93	5.48	3.78	2.91	3.74	3.04	3.20	2.62	2.47	3.05	1.13
17	1.19	3.91	6.87	4.70	5.70	2.47	3.76	2.89	4.52	7.06	4.31	1.88
18	0.62	0.87	4.54	2.20	4.18	1.02	1.40	1.49	0.22	2.08	1.86	1.45
19	0.08	2.97	5.42	1.93	2.58	1.10	1.06	1.54	0.93	1.81	1.94	1.48
20	2.39	3.08	6.89	5.13	5.70	2.24	4.39	4.17	2.63	3.98	4.06	1.53
21	1.73	3.39	4.27	4.15	2.57	3.69	5.37	2.19	4.38	6.09	3.78	1.37
22	1.74	3.07	5.35	3.40	4.47	3.56	2.87	2.21	3.00	5.75	3.54	1.29
23	1.25	1.03	1.17	2.35	1.90	1.44	1.81	2.10	2.07	2.88	1.80	0.58
24	0.91	4.02	6.19	2.49	2.80	1.86	2.99	1.32	2.47	2.66	2.77	1.49
25	2.19	3.48	8.45	4.16	5.90	3.88	5.65	3.59	4.01	5.28	4.66	1.74
26	0.39	1.74	4.29	2.35	3.17	1.21	1.65	0.74	0.94	4.16	2.06	1.39
27	1.66	4.53	9.38	2.87	3.18	4.13	2.88	1.95	4.25	4.37	3.92	2.17
28	1.02	1.56	4.46	3.79	4.23	1.74	3.54	2.11	2.32	3.25	2.80	1.21
29	0.86	1.42	4.39	3.08	3.49	2.67	1.13	1.58	0.99	1.88	2.15	1.20
30	1.77	2.51	7.16	4.04	5.88	3.40	4.39	2.38	4.66	5.50	4.17	1.71
31	3.02	4.70	9.98	6.73	7.54	4.86	7.17	2.69	5.97	9.81	6.25	2.51
32	0.29	0.39	5.59	3.01	4.34	2.78	2.07	1.92	2.42	2.80	2.56	1.61
33	3.25	5.18	9.18	4.87	5.21	2.86	4.92	3.20	5.89	5.81	5.04	1.82
34	2.16	5.18	8.12	4.50	3.87	2.88	5.17	2.98	4.85	4.59	4.43	1.66
35	0.18	0.47	3.57	1.77	3.22	1.19	1.95	0.98	0.16	1.69	1.52	1.18
36	0.97	1.88	2.23	3.12	1.93	2.94	2.05	2.35	3.14	1.95	2.26	0.67
37	0.80	1.63	5.12	2.46	2.29	2.10	1.88	1.67	2.42	2.35	2.27	1.12
38	1.94	3.11	4.15	5.83	3.42	3.55	5.21	3.72	4.13	6.24	4.13	1.31
39	1.52	4.76	7.07	2.86	4.55	4.53	3.04	1.76	3.84	8.16	4.21	2.13

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
40	0.60	0.43	2.90	1.35	1.44	0.87	0.90	0.59	0.58	1.22	1.09	0.73
41	1.47	3.43	2.85	3.09	1.79	2.87	2.46	1.87	3.39	3.87	2.71	0.79
42	1.32	3.19	6.12	2.65	3.61	2.46	2.67	1.56	3.95	5.85	3.34	1.62
43	0.66	1.99	3.74	2.36	3.18	2.71	2.76	1.20	0.92	5.36	2.49	1.42
44	0.69	3.37	7.51	3.10	5.06	2.27	3.17	2.30	2.18	3.18	3.28	1.86
45	1.46	4.46	6.78	2.90	4.16	2.45	3.39	2.38	2.29	5.42	3.57	1.64
46	-0.78	-0.40	3.54	0.22	1.64	1.35	-0.27	0.42	-0.37	1.43	0.68	1.32
47	1.63	2.71	7.55	5.86	5.41	5.94	6.22	2.69	4.14	8.17	5.03	2.17
48	0.88	3.25	4.90	1.74	1.71	0.49	1.46	0.98	2.05	2.35	1.98	1.30
49	3.39	5.78	13.23	6.94	9.78	7.37	6.04	3.62	7.40	10.96	7.45	3.12
50	0.95	3.79	6.88	3.27	2.17	3.59	2.52	2.40	3.02	5.21	3.38	1.67
51	2.54	3.25	4.62	4.37	3.61	3.87	4.82	2.80	5.40	10.34	4.56	2.22
52	0.95	1.26	1.98	3.24	2.26	2.19	1.89	1.63	2.95	4.26	2.26	0.99
53	0.68	2.08	2.86	1.76	3.40	2.05	1.67	1.32	2.83	2.79	2.14	0.83
54	0.85	1.86	3.53	4.34	3.47	4.14	3.26	1.46	2.25	7.25	3.24	1.82
55	1.45	2.48	4.12	4.26	3.77	5.66	5.61	1.58	2.81	8.68	4.04	2.20
56	1.63	3.95	7.51	4.41	3.20	3.83	5.88	1.06	3.98	8.86	4.43	2.42
57	0.17	1.95	4.74	0.94	1.42	-0.44	1.27	-0.21	1.63	2.09	1.36	1.48
58	2.41	5.20	10.29	5.33	7.51	4.77	6.55	2.25	5.79	9.91	6.00	2.70
59	1.58	2.38	6.25	3.62	2.50	3.96	1.44	2.50	1.66	1.11	2.70	1.55
60	-0.87	-0.92	0.88	-0.54	-1.37	1.18	-1.31	-0.20	-1.32	-1.24	-0.57	0.93
61	1.67	2.20	4.59	3.56	2.47	4.36	2.81	1.44	2.56	1.40	2.70	1.14
62	0.58	1.37	3.65	1.55	0.17	1.65	0.74	-0.08	0.61	2.62	1.29	1.15
63	0.69	1.53	4.58	2.97	3.55	3.11	1.99	1.07	1.96	0.99	2.24	1.27
64	0.21	1.44	2.35	1.40	-0.22	1.91	0.29	0.06	0.21	1.76	0.94	0.92
65	2.42	4.16	9.30	4.92	4.54	5.09	6.25	1.81	6.64	10.72	5.59	2.78
66	3.57	5.16	9.74	5.18	6.05	5.22	6.92	2.52	6.12	9.93	6.04	2.36
67	1.13	3.71	5.59	3.87	2.16	2.18	2.80	0.73	3.20	4.81	3.02	1.54
68	-0.56	0.53	1.29	0.54	0.73	-0.19	-0.69	0.21	-1.38	-0.33	0.02	0.79
69	-0.13	0.94	-1.34	1.07	-0.11	0.99	-0.74	0.52	0.86	-1.80	0.03	1.03
70	-1.00	1.23	0.26	1.16	-1.13	0.57	-0.54	-0.25	0.73	0.27	0.13	0.84
71	2.79	4.27	6.71	2.49	4.46	3.92	4.79	0.66	5.41	8.74	4.42	2.26
72	1.12	4.56	12.16	3.59	5.45	3.82	3.92	1.36	4.20	5.07	4.53	3.04
73	2.61	4.97	8.40	3.14	5.33	2.60	4.63	2.86	3.73	6.74	4.50	1.93
74	-0.15	1.27	0.13	1.76	0.47	0.95	1.40	0.35	1.94	5.19	1.33	1.53
75	1.46	3.03	9.57	2.49	4.29	4.37	3.03	0.88	4.37	5.40	3.89	2.44
76	0.33	4.68	9.98	2.80	5.45	4.22	2.28	1.39	3.08	6.79	4.10	2.82
77	-0.15	-0.21	0.21	1.12	-0.73	2.08	-0.79	0.29	0.39	0.17	0.24	0.85
78	0.77	4.72	3.34	2.92	1.22	1.57	2.82	1.57	2.90	6.24	2.81	1.68
79	1.10	3.71	3.04	3.80	1.10	2.66	3.73	0.61	1.34	3.88	2.50	1.32

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
80	-0.68	-0.46	0.85	0.97	0.20	0.69	0.08	-0.22	1.15	2.03	0.46	0.83
81	1.16	3.19	3.35	3.02	1.48	0.42	2.99	0.15	3.52	1.95	2.12	1.26
82	-0.31	2.95	3.67	-0.35	0.31	0.60	0.67	0.03	1.55	0.59	0.97	1.36
83	0.26	2.48	2.14	1.64	2.30	0.88	1.91	-0.77	3.14	3.67	1.76	1.33
84	-0.32	0.26	-0.20	0.10	-2.21	0.08	-0.02	-0.76	-0.39	0.01	-0.34	0.72
85	0.55	-0.30	-0.73	1.94	0.86	-0.11	0.96	0.29	2.23	1.59	0.73	0.98
86	0.39	0.74	1.75	1.27	1.13	0.53	3.06	-0.25	1.15	3.32	1.31	1.13
87	2.19	2.02	8.71	3.40	4.16	5.13	3.24	1.81	5.59	6.69	4.29	2.24
88	0.37	3.57	6.99	0.99	1.44	2.88	1.15	0.47	2.37	4.31	2.45	2.07
89	0.09	3.55	8.89	2.34	4.90	3.43	1.85	0.57	3.02	6.80	3.54	2.72
90	0.55	4.02	8.22	1.44	4.49	2.17	2.22	0.63	4.09	7.10	3.49	2.61
91	-0.46	2.64	4.29	0.55	2.29	-1.06	1.23	-0.33	2.63	1.91	1.37	1.69
92	1.87	1.23	1.93	2.46	3.38	2.94	3.17	-0.06	2.89	5.07	2.49	1.38
93	0.76	-0.15	-0.24	1.24	-0.94	0.64	2.16	-0.69	1.67	1.69	0.61	1.08
94	0.24	-0.22	-0.46	0.04	-0.67	-0.05	1.92	-0.97	1.43	2.86	0.41	1.24
95	0.65	1.76	2.52	2.27	-0.73	3.45	1.27	0.89	3.02	3.25	1.83	1.33
96	0.27	1.99	5.45	1.14	3.17	2.32	1.12	-0.07	2.93	3.41	2.17	1.66
97	-0.95	1.32	0.85	-0.25	0.75	0.48	-0.70	-0.57	1.83	3.41	0.62	1.34
98	-1.10	-0.60	-0.79	-0.77	0.07	2.10	-1.10	-1.52	1.09	3.62	0.10	1.66
99	-1.63	-0.09	0.10	-1.88	-3.24	-0.04	-2.60	-1.86	-0.36	-2.28	-1.39	1.20
100	-1.48	-0.15	-1.48	-1.12	-2.56	-1.37	-2.11	-1.14	-1.01	-1.63	-1.41	0.65
101	-1.08	-0.32	1.50	-1.08	0.43	-0.53	-1.82	-1.34	0.67	2.14	-0.14	1.29
102	-0.83	-0.51	0.83	-0.33	0.54	-0.53	-1.52	-1.37	0.36	0.21	-0.32	0.79
103	-0.63	1.66	2.30	-0.01	1.24	0.69	-0.72	-1.23	0.69	1.25	0.53	1.14
104	-0.10	1.02	2.92	1.19	2.41	1.38	0.30	-1.08	1.67	2.62	1.23	1.27
105	0.06	1.55	3.19	-0.22	0.72	-0.93	-0.82	-0.86	3.05	2.20	0.79	1.61
106	0.15	-0.70	-1.32	0.14	-0.34	0.93	0.59	-0.94	0.06	3.61	0.22	1.38
107	-0.46	2.36	5.63	-0.05	0.60	-2.15	-1.07	-0.45	3.33	-0.56	0.72	2.36
108	-1.24	-1.36	-0.26	0.01	1.63	0.45	-1.03	-1.77	-0.79	2.80	-0.16	1.44
109	0.08	-0.28	1.85	-0.78	1.93	-0.34	-0.26	-0.80	2.88	4.69	0.90	1.85
110	-1.96	-2.05	-2.16	-2.50	-1.38	-0.95	-2.94	-2.60	-0.54	0.60	-1.65	1.09
111	-0.01	-1.06	-0.22	-1.48	-1.64	-0.70	0.08	-1.81	1.24	1.71	-0.39	1.19
112	-0.82	-2.10	-3.22	-1.79	-2.67	-1.73	-3.37	-2.57	-2.02	-0.19	-2.05	1.00
113	-2.11	-0.18	-0.77	-2.50	-1.70	-2.82	-3.24	-2.27	-1.70	-0.62	-1.79	1.00
114	-2.47	0.01	-1.11	-2.74	-0.66	-3.97	-3.46	-1.80	-2.21	-0.42	-1.88	1.33
115	-2.34	-2.14	-3.26	-2.75	-1.81	-0.68	-3.47	-2.12	-1.09	0.84	-1.88	1.29
116	-2.03	0.92	2.03	-1.91	1.25	-2.52	-2.12	-2.09	1.08	3.04	-0.24	2.09
117	-1.28	-1.49	1.37	-0.33	1.67	-0.11	-1.71	-2.33	0.50	3.20	-0.05	1.75
118	-0.61	-1.72	-0.66	-0.54	0.13	-0.02	-2.92	-2.00	0.51	1.78	-0.61	1.35
119	-1.90	-0.07	0.26	-1.76	-0.88	-2.97	-1.54	-2.77	0.35	0.49	-1.08	1.30

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
120	-1.37	-1.60	-1.56	-1.94	-1.40	-2.48	-2.86	-1.75	-1.21	-1.15	-1.73	0.56
121	-1.92	-1.88	-1.90	-1.67	-2.34	-4.17	-3.07	-2.58	-2.31	-4.27	-2.61	0.94
122	-2.77	-1.81	-3.26	-4.74	-5.72	-6.33	-5.56	-2.82	-4.15	-6.30	-4.34	1.62
123	-2.25	-2.19	-4.91	-3.41	-4.94	-6.05	-4.71	-2.81	-3.60	-4.61	-3.95	1.29
124	-1.66	-2.27	-3.07	-4.71	-1.70	-3.21	-3.75	-2.67	-3.10	0.11	-2.60	1.32
125	-1.82	-1.25	-1.79	-3.48	-0.76	-2.23	-3.39	-2.38	-1.24	0.22	-1.81	1.14
126	-0.89	-1.76	-1.84	-2.12	-2.50	-3.24	-3.08	-2.71	-2.36	-2.82	-2.33	0.71
127	-2.63	-1.98	-3.11	-2.55	-2.61	-4.67	-3.83	-2.06	-2.97	-2.24	-2.87	0.84
128	-2.23	-1.81	-1.39	-3.30	-1.27	-3.32	-2.58	-2.92	-2.43	-1.06	-2.23	0.83
129	-2.37	-1.09	-2.50	-3.14	-3.09	-5.12	-4.26	-2.85	-2.89	-3.76	-3.11	1.10
130	-2.88	-2.35	-3.46	-4.83	-5.84	-7.40	-6.71	-4.08	-4.65	-7.91	-5.01	1.91
131	-3.12	-3.46	-5.11	-5.49	-3.99	-6.97	-7.18	-3.31	-3.88	-4.54	-4.71	1.46
132	-3.42	-2.45	-2.83	-3.74	-0.52	-7.59	-6.86	-3.07	-2.38	-2.33	-3.52	2.14
133	-1.94	-0.21	2.95	-3.10	-0.59	-5.85	-5.18	-2.93	-2.69	-5.62	-2.52	2.74
134	-3.19	-0.05	2.56	-3.40	-1.40	-5.47	-3.96	-2.30	-1.56	-4.11	-2.29	2.31
135	-2.84	0.10	1.70	-3.74	-0.58	-5.31	-4.97	-2.18	-1.92	-1.10	-2.08	2.22
136	-3.88	-0.40	2.27	-3.96	-0.96	-5.64	-5.24	-2.53	-1.27	-1.13	-2.27	2.44
137	-2.50	0.27	3.56	-2.53	-0.32	-4.98	-5.63	-1.73	-1.98	-2.27	-1.81	2.61
138	-3.46	0.20	0.71	-4.49	-3.37	-7.04	-6.38	-2.69	-3.99	-6.60	-3.71	2.65
139	-3.48	-0.02	1.35	-3.18	-1.38	-5.78	-6.88	-2.84	-4.04	-5.01	-3.13	2.55
140	-1.96	0.48	0.93	-0.85	0.71	-7.28	-5.48	-1.47	-2.64	-1.00	-1.85	2.68
141	-2.44	-2.40	0.54	-2.87	0.33	-6.01	-4.61	-2.77	-2.48	-3.31	-2.60	1.97
142	-3.23	-0.61	-1.87	-4.49	-2.10	-5.88	-5.15	-3.40	-3.43	-2.84	-3.30	1.58
143	-1.97	-0.55	-0.30	-2.87	-2.21	-5.19	-4.47	-2.63	-2.19	-3.76	-2.61	1.56
144	-3.37	-1.18	-5.92	-5.84	-9.30	-10.92	-8.49	-3.04	-4.54	-12.46	-6.51	3.67
145	-2.56	-1.00	-3.11	-4.29	-4.65	-5.89	-5.37	-1.96	-1.69	-5.76	-3.63	1.80
146	-1.56	0.66	1.37	-2.15	-3.74	-5.26	-3.98	-1.37	-1.62	-7.29	-2.49	2.63
147	-1.38	1.01	3.07	-2.15	-3.15	-5.13	-3.78	-0.18	-1.94	-3.77	-1.74	2.48
148	-2.62	0.21	1.65	-4.00	-4.21	-5.60	-4.97	-2.04	-3.07	-5.40	-3.01	2.40
149	-3.06	-0.20	-2.63	-4.01	-5.69	-7.97	-6.27	-2.52	-3.20	-6.98	-4.25	2.41
150	-3.14	-1.06	-1.89	-3.91	-6.40	-6.53	-6.17	-2.82	-3.92	-7.97	-4.38	2.27
151	-2.75	1.15	0.41	-2.86	-2.42	-3.95	-4.75	-1.97	-2.81	-2.55	-2.25	1.79
152	-2.89	1.69	1.92	-3.86	-4.91	-7.08	-4.90	-2.07	-1.39	-6.55	-3.00	3.11
153	-1.98	0.20	0.48	-3.36	-2.57	-3.65	-5.00	-1.97	-1.87	-1.53	-2.12	1.66
154	-2.43	1.11	5.07	-1.80	-0.01	-4.85	-3.72	-1.20	0.23	-3.83	-1.14	2.92
155	-2.70	1.57	6.07	-1.18	-0.14	-3.03	-3.60	-1.11	0.35	-4.31	-0.81	3.05
156	-1.08	3.24	5.66	-0.56	-1.27	-0.72	-2.70	-0.63	0.01	-3.51	-0.16	2.71
157	-1.49	4.45	6.33	-0.10	0.16	-1.11	-3.18	-0.72	0.66	-2.27	0.27	2.96
158	-0.76	3.89	6.84	0.22	1.20	-1.45	-2.10	-0.29	0.33	0.80	0.87	2.66
159	-1.36	2.54	3.29	-1.88	-2.29	-2.67	-2.92	-0.15	-0.01	-2.11	-0.76	2.17



Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
160	-0.91	3.07	6.43	-0.32	0.58	-0.64	-1.28	-0.10	0.36	0.59	0.78	2.32
161	-2.13	4.93	10.00	-0.16	0.91	0.13	-1.41	0.56	-0.16	1.92	1.46	3.57
162	-1.56	3.73	6.19	-2.43	0.20	-0.68	-2.34	-2.21	-0.60	-0.23	0.01	2.82
163	-2.34	3.21	7.02	-1.26	0.64	-2.22	-2.09	-1.60	1.38	-0.59	0.22	2.99
164	-1.38	2.71	8.18	-1.16	1.63	-1.07	-2.42	-1.01	1.22	0.09	0.68	3.07
165	-1.05	2.89	5.05	-0.51	2.58	-0.73	-1.59	-1.76	1.75	3.10	0.97	2.39
166	0.07	4.52	9.15	-0.46	3.86	-0.68	-0.51	-0.28	2.42	3.25	2.13	3.18
167	0.36	5.68	11.23	2.33	4.47	3.81	2.25	0.50	4.90	5.82	4.14	3.17
168	0.41	6.00	13.54	2.04	6.13	3.63	0.83	0.64	4.90	7.59	4.57	4.06
169	0.03	5.49	13.28	2.40	6.21	6.52	2.31	1.09	6.10	7.33	5.08	3.85
170	-0.59	5.38	12.91	0.97	7.38	5.93	1.13	0.44	2.90	9.21	4.57	4.38
171	1.01	7.04	14.28	3.01	8.37	5.29	2.64	0.14	4.65	8.49	5.49	4.23
172	1.03	5.96	13.85	2.59	11.09	6.04	4.72	0.83	4.40	9.90	6.04	4.35
173	1.43	7.60	18.58	3.53	11.55	8.76	4.96	0.63	5.29	13.79	7.61	5.69
174	1.09	8.24	13.67	3.77	7.92	10.53	4.57	1.86	4.62	13.53	6.98	4.54
175	0.04	7.84	12.88	5.29	8.20	9.58	4.47	2.35	3.16	15.14	6.90	4.76
176	2.60	6.19	12.07	5.68	5.48	10.47	4.59	2.27	5.21	6.40	6.10	3.08
177	3.38	6.49	13.38	6.05	7.32	13.23	5.93	3.40	6.34	8.39	7.39	3.48
178	2.25	7.79	13.01	6.27	7.94	12.35	6.38	2.19	7.22	12.05	7.75	3.84
179	4.78	9.50	17.75	9.15	10.65	16.05	10.25	4.11	10.39	15.63	10.82	4.53
180	5.27	9.82	19.45	10.02	13.11	17.11	11.94	4.12	9.61	17.11	11.76	5.06
181	4.34	7.67	14.25	8.52	10.19	16.00	10.39	2.95	8.82	15.75	9.89	4.45
182	5.67	5.38	12.09	7.63	10.38	16.76	12.35	3.04	9.10	15.90	9.83	4.54
183	4.61	7.50	17.29	6.75	10.93	18.43	11.01	3.46	10.04	16.32	10.63	5.28
184	5.66	5.11	11.50	9.30	10.60	18.00	12.57	3.03	8.59	16.76	10.11	4.86
185	6.67	5.92	15.45	11.28	13.20	24.84	14.81	4.07	11.22	20.13	12.76	6.46
186	7.07	6.18	17.52	12.00	15.71	25.01	15.93	4.80	14.38	26.82	14.54	7.45
187	7.55	6.72	16.24	8.68	12.41	21.61	14.45	4.37	10.15	19.41	12.16	5.69
188	7.84	6.68	17.67	9.38	12.41	23.00	16.41	5.32	12.43	21.61	13.28	6.20
189	5.85	5.45	14.43	7.44	9.53	19.55	13.79	3.11	10.47	17.31	10.69	5.44
190	7.38	6.62	15.78	11.72	16.11	26.56	17.68	5.56	12.27	27.79	14.75	7.75
191	6.66	4.96	16.91	12.14	20.09	26.39	16.70	5.00	12.52	31.45	15.28	8.92
192	8.76	5.14	17.38	12.82	21.48	30.18	17.66	5.27	13.10	33.58	16.54	9.69
193	8.47	5.92	18.13	15.79	21.78	30.43	20.86	5.56	16.24	34.91	17.81	9.79
194	9.15	5.04	18.82	15.17	22.59	30.75	20.04	5.92	14.03	34.09	17.56	9.78
195	8.50	5.68	17.68	13.96	20.96	29.63	21.03	5.69	14.12	31.92	16.92	9.19
196	9.42	5.15	16.35	15.44	21.80	30.63	19.81	6.52	14.68	29.86	16.97	8.81
197	8.45	3.94	15.93	12.95	19.76	26.83	18.15	5.20	14.08	30.18	15.55	8.61
198	9.27	4.76	17.87	13.02	20.56	26.80	20.92	5.94	14.34	29.94	16.34	8.45
199	8.35	4.34	12.79	11.94	17.71	24.64	18.63	5.52	14.33	27.63	14.59	7.70

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
200	8.38	3.27	9.95	12.29	19.34	21.85	18.17	5.19	13.46	30.40	14.23	8.30
201	6.70	2.83	10.49	11.45	17.50	21.19	16.17	5.01	11.54	26.70	12.96	7.48
202	8.55	3.49	11.28	12.74	17.28	24.13	17.44	5.21	12.77	28.44	14.13	7.90
203	8.88	2.86	10.78	12.49	18.45	22.24	16.88	5.54	14.20	25.85	13.82	7.23
204	9.90	3.74	10.17	13.85	16.79	23.42	18.79	6.23	13.50	26.93	14.33	7.32
205	9.89	2.77	11.23	13.55	17.66	22.32	18.09	6.34	13.84	26.39	14.21	7.17
206	8.45	3.05	9.41	12.51	16.14	21.00	16.27	5.72	12.99	27.26	13.28	7.25
207	8.73	2.54	11.29	13.05	18.12	23.92	18.32	4.97	14.35	26.66	14.19	7.77
208	9.67	3.91	13.48	15.21	18.30	26.64	20.09	6.51	16.07	25.74	15.56	7.54
209	9.97	3.12	12.73	16.62	18.75	26.19	20.31	6.43	16.80	26.00	15.69	7.71
210	10.45	4.08	15.57	18.53	21.17	30.26	22.58	7.67	19.45	30.79	18.05	8.89
211	11.83	3.90	13.42	17.82	20.28	29.74	24.26	8.07	18.87	32.08	18.03	9.05
212	12.47	4.68	12.68	20.30	23.08	30.11	26.44	9.52	19.06	33.10	19.15	9.27
213	14.04	4.70	14.47	21.80	24.22	32.00	27.59	9.21	21.36	37.92	20.73	10.31
214	14.20	4.26	16.74	21.97	25.07	33.13	26.65	8.40	20.23	37.16	20.78	10.33
215	15.81	4.89	20.34	24.11	26.68	38.77	30.35	9.73	25.96	42.22	23.89	11.79
216	17.46	7.13	23.65	28.79	32.25	43.53	35.43	12.47	30.31	44.43	27.54	12.45
217	19.26	7.71	22.95	28.48	31.91	43.88	36.42	12.74	26.46	47.09	27.69	12.70
218	20.29	8.93	25.84	29.61	34.26	46.75	39.02	13.93	29.96	52.29	30.09	13.71
219	19.14	8.56	26.57	29.10	35.26	45.13	37.92	13.44	29.92	46.18	29.12	12.64
220	21.10	9.09	28.86	29.49	35.70	47.24	39.34	13.44	30.78	53.34	30.84	13.94
221	21.14	9.94	28.98	31.94	36.85	49.07	41.18	14.72	31.95	55.95	32.17	14.47
222	23.42	10.46	29.34	31.76	34.95	49.86	42.34	15.23	33.18	49.30	31.99	13.17
223	23.51	11.29	28.84	32.17	32.44	48.02	42.14	15.60	32.18	45.47	31.17	12.08
224	20.13	9.91	24.89	31.38	30.25	45.35	38.67	15.19	28.85	42.72	28.73	11.58
225	20.27	9.89	25.14	26.73	29.49	41.60	34.50	13.68	28.62	44.89	27.48	11.13
226	20.44	9.79	26.33	28.19	31.85	42.73	36.56	15.39	28.51	47.09	28.69	11.62
227	19.86	10.18	24.77	27.44	29.27	42.66	35.62	14.53	27.58	44.73	27.66	11.20
228	20.83	11.01	25.76	27.97	27.66	42.20	36.72	14.45	29.37	40.37	27.64	10.33
229	19.95	9.62	23.75	26.81	28.42	38.08	34.53	13.09	27.61	38.01	25.99	9.71
230	18.56	8.43	21.08	25.34	25.94	36.58	33.31	11.88	24.75	37.60	24.35	9.79
231	17.32	7.15	22.33	24.31	25.07	34.15	31.06	10.41	24.18	36.46	23.24	9.54
232	17.39	8.57	24.87	23.72	25.16	33.39	30.65	11.21	24.49	35.06	23.45	8.82
233	17.61	8.58	23.01	23.61	24.51	33.93	30.76	11.54	25.25	35.87	23.47	8.94
234	18.47	9.43	20.57	22.81	22.96	33.92	30.16	11.77	25.14	36.79	23.20	8.83
235	19.52	9.16	21.78	21.78	22.57	33.08	29.84	11.52	26.54	33.49	22.93	8.23
236	18.91	8.62	20.44	22.03	22.25	33.50	31.20	12.36	26.19	31.37	22.69	8.17

(Sheet 6 of 6)

Table D4. Gross longshore transport rates, change = P1 - Ex, 1990-1999, 1,000 cu yd/yr.

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
1	-0.21	-0.11	1.58	0.60	3.11	-1.14	0.19	1.70	-2.51	-2.81	0.04	1.86
2	0.35	1.23	0.78	1.30	0.52	-1.36	1.63	1.82	-0.04	-2.24	0.40	1.31
3	-0.06	0.48	2.94	0.62	1.95	0.93	-0.08	0.55	0.66	0.90	0.89	0.92
4	0.02	0.92	1.41	0.95	1.33	0.51	0.43	0.99	0.16	2.24	0.90	0.66
5	0.36	-1.01	-0.67	2.05	2.53	-0.62	1.39	1.60	-0.35	1.37	0.66	1.27
6	0.29	-0.72	-1.80	0.33	0.03	-1.44	0.29	-0.01	0.32	0.00	-0.27	0.78
7	0.38	0.19	1.14	-0.06	0.99	-0.67	1.30	0.65	-1.08	1.03	0.39	0.80
8	0.18	-0.19	0.82	-0.02	0.74	-0.19	0.66	-0.23	-0.61	-0.24	0.09	0.49
9	-0.02	-0.18	0.09	-0.76	-0.14	-1.14	0.59	0.59	-0.61	0.36	-0.12	0.58
10	-0.06	0.28	-0.70	-0.30	-0.59	-0.68	-0.16	-0.28	-0.90	-0.85	-0.42	0.38
11	0.12	-0.76	-1.86	-0.83	0.73	-2.32	-1.33	-0.06	-1.04	-0.08	-0.74	0.94
12	-1.22	-1.26	-1.16	-2.19	0.45	-2.16	-2.56	-0.60	-1.78	-1.65	-1.41	0.88
13	0.00	0.13	2.75	-0.93	1.81	-0.38	0.62	0.49	-1.64	0.04	0.29	1.26
14	-0.29	-0.55	-3.16	-1.48	-0.51	-3.22	0.32	-0.11	-1.29	-1.23	-1.15	1.21
15	-0.56	-1.48	-3.11	0.54	-0.34	-0.08	-0.75	1.17	-1.96	-1.43	-0.80	1.25
16	0.62	0.80	-1.71	-0.17	-0.11	-1.90	-0.28	0.88	-1.09	0.67	-0.23	1.03
17	-0.24	-1.27	-3.27	-0.91	0.64	-0.30	0.01	1.01	-2.52	-2.05	-0.89	1.39
18	0.06	0.20	1.33	1.24	2.20	-0.50	1.10	0.31	0.18	0.01	0.61	0.82
19	0.23	-1.49	-3.05	0.35	0.01	-0.51	-0.18	0.66	-0.04	-0.55	-0.46	1.09
20	-1.22	-0.34	-1.05	1.21	2.22	-0.80	0.99	0.42	-0.93	-0.68	-0.02	1.17
21	-1.08	-2.25	-0.33	-2.86	0.20	-2.55	-3.32	-0.64	-4.00	-4.26	-2.11	1.57
22	0.36	-0.06	-0.04	-0.68	-0.28	-1.85	0.13	0.34	-2.25	1.33	-0.30	1.06
23	0.11	0.45	0.84	-0.78	0.67	-0.58	0.70	0.10	-1.77	-0.50	-0.08	0.82
24	-0.41	-2.94	-5.21	-1.43	-1.57	-1.43	-2.00	-0.13	-2.26	-1.61	-1.90	1.42
25	0.02	0.04	0.44	0.07	2.56	-2.84	-1.14	0.52	-2.41	-1.90	-0.46	1.62
26	-0.05	0.11	0.32	0.02	0.86	-0.32	-0.46	-0.25	-0.41	2.23	0.21	0.81
27	-0.42	-3.66	-6.10	-1.67	0.03	-3.62	-1.35	-1.09	-4.01	-1.93	-2.38	1.91
28	0.06	0.13	2.41	-0.87	2.20	-0.98	0.21	0.55	-1.66	-0.71	0.13	1.33
29	0.04	0.82	-1.17	-0.26	-0.17	-1.77	0.13	1.25	-0.06	0.30	-0.09	0.87
30	-1.05	-1.80	2.10	-1.21	0.90	-2.72	-1.60	-0.08	-3.89	-2.92	-1.23	1.81
31	-2.49	-4.19	-2.06	-4.42	-0.72	-4.22	-4.29	-1.01	-5.58	-7.48	-3.65	2.09
32	0.16	0.24	1.24	0.19	2.57	-1.62	1.07	0.74	-1.53	0.16	0.32	1.24
33	-2.40	-3.60	-5.79	-2.74	-3.10	-1.91	-2.80	-0.58	-4.64	-3.62	-3.12	1.44
34	-1.66	-3.88	-4.95	-2.98	-2.72	-2.28	-3.04	-1.69	-3.80	-3.66	-3.07	1.04
35	0.55	0.35	2.03	0.75	2.29	-0.85	1.44	0.14	0.15	-0.03	0.68	0.97
36	0.44	0.75	0.57	-0.18	-0.04	-0.94	0.86	0.68	-1.62	0.36	0.09	0.81
37	0.22	-0.22	-1.29	-0.68	-0.94	-1.12	-0.15	0.21	-2.03	-0.69	-0.67	0.71
38	-0.50	-0.40	0.02	-2.19	0.38	-1.37	-1.52	0.50	-2.42	-2.74	-1.02	1.19
39	-1.18	-3.96	-5.79	-1.59	-2.89	-4.22	-2.16	-1.72	-3.69	-6.66	-3.39	1.83

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
40	1.11	0.92	0.48	0.18	0.60	0.04	0.61	0.95	-0.28	0.66	0.53	0.44
41	-0.28	-1.97	0.05	-1.80	-0.47	-1.85	-0.64	0.00	-3.01	-2.33	-1.23	1.09
42	0.13	-1.94	-2.31	-1.28	-1.85	-1.99	-1.04	-0.16	-3.54	-4.03	-1.80	1.32
43	0.17	-0.01	-1.27	-0.72	0.77	-2.26	-0.54	0.66	0.02	-2.96	-0.61	1.23
44	-0.28	-3.17	-2.26	-1.50	-0.60	-2.09	-0.62	-1.25	-2.09	-1.96	-1.58	0.90
45	-0.45	-3.69	-3.84	-1.77	-2.42	-2.04	-1.46	-1.21	-1.97	-4.35	-2.32	1.26
46	1.09	1.17	1.05	0.63	2.32	-1.01	1.41	0.59	0.50	-0.49	0.73	0.94
47	-1.46	-2.19	-2.85	-3.98	-0.54	-5.68	-3.48	-1.55	-3.99	-6.70	-3.24	1.93
48	0.27	-2.73	-3.84	-1.24	-0.54	-0.46	-1.06	-0.39	-2.11	-1.80	-1.39	1.25
49	-1.63	-4.12	-5.49	-3.02	-3.32	-6.11	-2.83	-1.38	-7.05	-8.15	-4.31	2.30
50	-0.49	-2.72	-4.07	-2.08	-1.35	-3.25	-1.38	-1.59	-2.96	-0.51	-2.04	1.19
51	-1.57	-1.88	-2.21	-3.21	-2.30	-3.12	-3.17	-1.97	-5.18	-5.75	-3.04	1.41
52	-0.46	-0.45	-0.36	-1.68	-0.46	-1.58	-0.41	0.65	-2.44	-2.62	-0.98	1.05
53	-0.01	-1.20	-1.76	-0.65	-2.62	-1.37	-0.18	-0.37	-2.61	-1.72	-1.25	0.95
54	-0.23	-0.96	0.14	-1.10	-0.21	-3.24	-1.33	0.25	-2.08	-6.06	-1.48	1.93
55	-0.83	-1.72	-1.81	-1.92	-1.42	-4.82	-3.14	-0.73	-2.36	-7.22	-2.60	2.01
56	-2.01	-4.12	-6.81	-3.96	-3.90	-3.90	-6.30	-1.90	-4.01	-8.89	-4.58	2.17
57	0.72	-1.75	-3.28	-0.05	0.23	0.61	0.00	0.06	-1.54	-1.32	-0.63	1.29
58	-1.55	-4.24	-3.61	-3.20	-2.20	-4.23	-3.99	-0.82	-5.38	-8.11	-3.73	2.06
59	-0.60	-1.41	-4.77	-2.56	-1.85	-2.98	-0.22	-1.03	-0.71	-0.67	-1.68	1.40
60	1.30	1.17	0.05	0.91	1.26	-0.31	1.83	0.26	1.43	1.77	0.97	0.73
61	-1.30	-1.40	-2.16	-2.55	-2.07	-3.85	-2.22	-1.15	-2.40	-0.64	-1.97	0.90
62	-0.01	-1.21	-2.96	-0.84	-0.24	-1.68	-0.31	0.21	-0.88	-1.11	-0.90	0.93
63	0.85	0.25	4.17	-0.21	2.15	-1.46	1.90	0.67	-0.57	1.08	0.88	1.59
64	0.26	-1.49	-2.00	-0.85	0.08	-1.75	-0.25	-0.37	-0.60	-0.61	-0.76	0.76
65	-2.47	-4.29	-7.60	-4.76	-4.61	-5.15	-5.92	-2.22	-6.81	-10.31	-5.41	2.41
66	-3.61	-5.69	-7.86	-4.96	-5.42	-5.68	-6.08	-2.97	-6.28	-9.74	-5.83	1.94
67	-1.12	-4.18	-4.41	-4.32	-2.86	-2.37	-2.67	-1.54	-3.57	-5.05	-3.21	1.31
68	2.01	0.23	0.99	2.42	2.67	0.77	2.83	0.47	1.54	2.08	1.60	0.94
69	1.30	-0.35	1.39	0.03	0.39	0.07	1.68	0.43	-0.41	-0.24	0.43	0.77
70	1.61	0.07	0.87	0.80	1.40	0.63	1.75	1.23	-0.13	1.11	0.93	0.62
71	-2.45	-5.62	-7.79	-4.06	-5.83	-4.66	-5.15	-2.57	-6.27	-9.38	-5.38	2.15
72	-0.89	-4.25	-9.82	-3.04	-5.27	-3.77	-3.85	-1.67	-4.21	-4.53	-4.13	2.40
73	-2.02	-4.80	-8.08	-3.25	-4.25	-2.62	-4.01	-2.76	-3.91	-6.11	-4.18	1.81
74	0.30	-1.39	0.36	-1.20	0.09	-0.51	-1.01	0.19	-1.69	-4.48	-0.93	1.46
75	-1.48	-3.46	-9.18	-2.51	-4.70	-3.80	-2.97	-1.13	-4.52	-5.37	-3.91	2.30
76	0.08	-3.30	-8.15	-1.77	-4.93	-3.37	-0.76	-0.29	-2.35	-6.24	-3.11	2.68
77	1.44	0.43	1.65	-0.14	0.44	-0.59	1.34	0.43	0.06	0.55	0.56	0.72
78	0.49	-3.97	-1.43	-2.18	-1.63	-0.45	-1.35	-1.17	-2.49	-5.54	-1.97	1.73
79	-1.06	-4.50	-2.86	-4.14	-1.51	-3.00	-4.06	-1.28	-1.47	-3.78	-2.76	1.33

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
80	1.52	0.07	0.94	-0.31	-1.18	1.03	1.04	0.09	-1.31	-0.92	0.10	1.02
81	0.16	-3.35	-2.90	-1.83	-2.55	1.77	-2.00	0.56	-2.14	-1.87	-1.42	1.67
82	0.13	-3.60	-2.66	-0.54	-0.41	-1.30	-0.50	-1.66	-2.24	-0.59	-1.34	1.19
83	-0.30	-3.38	-2.24	-2.40	-2.23	-1.38	-2.30	-0.26	-3.60	-3.53	-2.16	1.21
84	0.69	-0.65	0.60	-0.55	1.18	0.52	-0.08	-0.02	0.28	-0.24	0.17	0.58
85	0.00	-0.18	2.04	-0.85	-0.98	1.06	0.93	0.41	-1.82	-1.38	-0.08	1.21
86	-0.32	-1.64	3.13	-1.89	1.06	-0.68	-2.73	-0.87	-1.48	-3.65	-0.91	1.92
87	-0.84	-1.59	-6.98	-2.39	-4.59	-3.26	-1.75	-1.05	-5.04	-5.55	-3.30	2.12
88	0.29	-3.55	-6.28	-1.47	-2.50	-2.19	-0.91	-1.61	-2.76	-4.54	-2.55	1.88
89	0.89	-3.42	-6.88	-0.99	-3.68	-1.92	0.34	-0.30	-2.91	-6.18	-2.50	2.63
90	-0.62	-5.06	-8.75	-2.87	-7.06	-2.20	-3.40	-2.52	-4.64	-7.76	-4.49	2.66
91	0.35	-2.97	-4.18	-1.09	-3.21	0.96	-1.48	-0.50	-2.97	-2.62	-1.77	1.69
92	-1.89	-1.99	-2.24	-3.03	-4.50	-2.96	-3.53	-0.93	-3.15	-5.33	-2.96	1.30
93	-0.54	-0.62	0.01	-1.64	-1.60	-0.63	-2.47	-0.28	-1.83	-3.24	-1.28	1.05
94	-0.40	-0.93	-0.15	-1.30	0.02	-0.68	-2.65	-0.90	-1.91	-3.82	-1.27	1.21
95	1.08	-1.35	-0.99	-1.18	-0.25	-0.75	-0.70	-0.38	-1.74	-2.29	-0.85	0.92
96	0.45	-3.13	-5.34	-2.04	-4.68	-2.33	-1.12	-0.79	-3.06	-6.94	-2.90	2.25
97	0.84	-2.42	-1.49	-0.58	-1.90	-0.82	0.07	-0.63	-2.22	-4.06	-1.32	1.41
98	0.91	-0.62	-0.34	-0.39	-1.96	-2.53	0.25	-0.12	-1.47	-4.76	-1.10	1.65
99	2.33	-0.59	0.69	0.62	1.40	-0.13	2.38	0.16	-0.09	1.20	0.80	1.02
100	1.44	-0.12	0.78	0.36	1.14	0.81	1.27	-0.39	0.82	1.28	0.74	0.61
101	0.91	-0.72	-2.38	-0.36	-2.50	-0.21	1.03	-0.34	-1.39	-3.47	-0.94	1.48
102	0.81	-1.14	-1.82	-0.84	-2.18	0.09	0.97	-0.24	-0.83	-1.64	-0.68	1.08
103	1.05	-1.91	-3.04	-0.83	-2.91	-0.41	0.41	0.01	-0.92	-2.45	-1.10	1.42
104	0.41	-1.97	-3.87	-2.61	-4.50	-1.96	-1.08	-0.82	-2.34	-4.31	-2.30	1.59
105	-0.12	-2.89	-2.94	-1.52	-3.11	0.29	-0.05	-1.48	-3.79	-3.69	-1.93	1.56
106	-0.15	-0.55	0.27	-1.11	-1.74	-1.26	-1.49	-0.84	-0.53	-4.96	-1.24	1.44
107	0.39	-3.80	-5.44	-1.58	-2.53	1.98	-0.01	-0.92	-4.04	-0.85	-1.68	2.28
108	1.07	-0.07	-0.95	-1.67	-3.71	-0.94	0.66	0.11	-0.01	-4.49	-1.00	1.83
109	-0.14	-1.27	-1.73	-1.42	-4.42	-0.49	-0.85	-1.39	-3.65	-6.68	-2.20	2.07
110	1.71	-0.39	-2.01	0.55	-3.98	0.44	1.27	-0.15	0.08	-5.65	-0.81	2.37
111	-0.93	-1.59	-1.12	-1.13	-1.51	-0.35	-1.76	-1.60	-2.22	-7.35	-1.95	1.96
112	1.08	0.29	1.54	-0.41	-0.44	0.91	2.06	-0.45	1.03	-2.01	0.36	1.20
113	2.42	-2.17	-0.86	0.51	-1.14	2.11	2.01	-0.09	0.85	-1.05	0.26	1.58
114	2.40	-0.33	0.22	1.65	-1.05	3.08	2.26	0.22	1.97	-1.49	0.89	1.58
115	2.16	0.94	2.17	1.05	-1.95	0.31	2.20	0.07	0.63	-3.61	0.40	1.88
116	1.76	-1.94	-3.25	0.12	-3.64	2.13	1.09	-0.21	-1.87	-4.77	-1.06	2.39
117	1.38	-0.10	-0.94	-1.44	-4.09	-0.80	1.07	-0.21	-1.19	-5.32	-1.16	2.10
118	0.25	-0.37	-1.63	-1.92	-3.85	-0.85	0.60	-0.84	-1.46	-4.02	-1.41	1.55
119	1.42	-2.01	-2.32	-1.00	-3.01	2.11	-0.36	-0.51	-1.32	-3.79	-1.08	1.85

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
120	1.42	-0.13	0.02	0.06	-1.34	2.11	1.90	-0.42	0.51	-0.89	0.32	1.16
121	0.95	-0.37	0.20	-0.47	-1.19	2.90	1.54	-0.56	1.05	1.56	0.56	1.26
122	2.44	0.01	2.27	2.29	1.76	5.47	4.17	-0.10	3.16	3.50	2.50	1.72
123	1.74	0.42	3.57	1.30	1.55	5.49	3.47	0.14	2.73	2.39	2.28	1.61
124	1.96	0.22	2.65	1.75	-0.93	2.32	2.55	-0.47	2.15	-2.22	1.00	1.72
125	1.51	-0.47	0.02	1.57	-2.97	1.80	2.33	0.07	0.56	-2.54	0.19	1.79
126	0.61	-0.31	0.25	-0.82	-1.85	2.11	1.07	-0.67	1.31	-0.30	0.14	1.17
127	3.77	0.48	3.03	1.51	0.33	5.41	3.58	0.86	3.56	0.68	2.32	1.77
128	1.82	-0.15	0.06	0.54	-2.37	2.35	1.31	-0.02	1.47	-1.27	0.38	1.45
129	2.27	-0.65	2.04	0.68	0.13	4.05	2.78	-0.10	2.10	1.54	1.48	1.46
130	3.26	-0.01	3.44	1.56	1.51	5.99	4.55	0.28	3.63	4.89	2.91	2.01
131	3.18	1.92	3.25	2.61	1.01	5.85	5.92	0.60	2.82	1.67	2.88	1.81
132	3.44	1.02	3.71	2.73	-0.77	6.70	5.96	0.41	1.43	0.09	2.47	2.50
133	2.00	-1.04	-0.22	0.58	-0.04	5.17	3.18	0.32	2.07	2.33	1.43	1.87
134	2.95	-0.84	-0.12	1.93	2.17	5.22	2.94	0.02	1.13	1.63	1.70	1.78
135	2.74	-0.64	2.80	2.43	0.97	5.64	3.96	-0.38	1.28	1.74	2.05	1.91
136	4.55	0.23	2.98	3.51	1.07	7.45	5.27	1.07	1.82	3.55	3.15	2.22
137	3.26	-0.84	-2.84	1.89	-2.39	6.75	5.15	1.23	2.66	1.04	1.59	3.08
138	4.14	-0.40	-0.81	2.75	0.94	7.75	5.26	0.86	3.42	5.05	2.90	2.75
139	3.68	-1.09	-2.53	0.84	-1.88	5.62	5.38	0.12	3.13	2.70	1.60	2.94
140	3.57	0.55	3.35	2.82	0.53	9.10	6.67	2.35	3.74	3.36	3.60	2.60
141	2.59	0.36	-0.89	0.76	-1.36	5.26	3.99	0.77	1.47	0.94	1.39	2.06
142	2.86	-1.02	0.74	1.49	-1.92	4.25	2.53	-0.03	2.52	-1.01	1.04	2.02
143	1.88	-0.51	0.57	1.43	-0.58	4.40	3.29	-0.41	1.03	3.47	1.46	1.79
144	2.82	-0.41	2.84	3.41	4.83	10.09	6.18	0.32	3.88	9.13	4.31	3.40
145	3.27	-0.41	1.65	3.27	2.29	6.89	5.29	1.59	2.32	4.74	3.09	2.10
146	1.52	-1.84	-0.41	0.70	-0.07	6.66	3.20	0.20	2.07	5.37	1.74	2.66
147	2.09	-1.83	-1.15	2.66	1.84	7.13	4.16	0.55	2.65	3.03	2.11	2.57
148	1.96	-1.95	-1.88	1.65	0.08	4.59	3.20	-0.14	1.91	2.09	1.15	2.11
149	3.21	-0.46	2.69	3.06	3.94	7.88	6.66	0.72	3.25	7.68	3.86	2.79
150	2.45	-0.68	0.66	1.61	1.72	6.53	4.42	-0.07	2.91	4.95	2.45	2.30
151	2.47	-2.22	-2.25	1.88	0.49	3.23	4.46	0.75	1.81	-0.30	1.03	2.20
152	2.73	-2.64	-1.82	3.11	2.49	6.78	4.95	0.23	1.36	4.53	2.17	2.97
153	2.09	-0.30	0.31	3.23	0.34	5.35	4.47	0.91	2.51	3.02	2.19	1.88
154	2.61	-1.95	0.22	1.84	1.85	6.70	3.90	0.46	0.36	2.89	1.89	2.37
155	2.97	-1.60	-0.33	2.02	2.96	5.46	4.22	1.01	0.64	7.48	2.48	2.74
156	1.28	-3.64	-4.82	0.48	0.22	2.77	2.33	0.10	0.85	2.55	0.21	2.54
157	1.65	-4.66	-5.15	0.58	-0.22	3.22	2.73	0.41	0.24	1.88	0.07	2.85
158	1.70	-3.48	-2.45	1.84	0.78	3.78	3.61	0.89	0.97	0.47	0.81	2.30
159	1.73	-1.68	-1.01	1.15	-0.04	2.63	2.35	-0.01	0.40	0.42	0.59	1.39

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
160	1.54	-2.33	-0.41	3.05	1.63	1.22	3.58	0.03	0.24	2.01	1.06	1.74
161	2.66	-4.06	-4.76	1.50	-0.99	1.11	3.19	0.40	0.83	0.74	0.06	2.63
162	1.44	-3.81	-2.94	0.84	0.49	0.46	2.00	-0.31	-0.27	-0.86	-0.29	1.84
163	0.82	-3.96	-6.55	0.24	0.43	1.60	2.02	-0.60	-2.30	-0.30	-0.86	2.68
164	1.19	-3.04	-7.50	0.14	-0.26	0.90	2.65	0.16	-1.67	0.39	-0.70	2.85
165	1.09	-3.61	-5.35	-0.31	-3.47	0.48	1.22	0.91	-2.23	-3.91	-1.52	2.47
166	-0.39	-4.11	-8.23	-0.77	-4.30	0.83	0.10	-0.67	-2.65	-3.50	-2.37	2.75
167	0.06	-3.94	-8.69	-1.05	-5.02	-1.34	-1.49	0.17	-3.52	-5.18	-3.00	2.80
168	0.11	-5.25	-11.75	-1.73	-5.91	-1.21	0.03	-0.58	-3.85	-7.70	-3.78	3.89
169	0.19	-3.83	-11.40	-1.21	-5.32	-3.60	-1.17	-0.34	-4.78	-6.28	-3.78	3.48
170	0.26	-4.65	-7.21	-1.42	-4.87	-5.10	-1.07	-1.80	-2.77	-10.35	-3.90	3.21
171	-1.51	-8.02	-11.26	-3.84	-5.73	-5.72	-2.61	-2.72	-5.21	-10.00	-5.66	3.24
172	-1.47	-6.67	-10.06	-3.44	-5.93	-6.36	-3.66	-1.40	-4.85	-10.02	-5.39	3.06
173	-1.55	-7.50	-13.82	-4.78	-10.06	-8.77	-5.04	-2.38	-5.70	-14.65	-7.42	4.44
174	-1.63	-6.70	-12.58	-3.64	-9.23	-9.38	-4.60	-2.38	-4.21	-14.29	-6.87	4.35
175	0.85	-5.23	-8.70	-1.17	-6.85	-6.20	-2.34	0.44	-1.01	-11.37	-4.16	4.13
176	-2.47	-5.08	-11.97	-4.69	-7.08	-7.75	-4.17	-1.77	-4.22	-7.09	-5.63	2.96
177	-3.56	-5.31	-12.86	-6.06	-8.13	-10.82	-6.41	-2.34	-5.43	-8.23	-6.91	3.19
178	-2.73	-6.83	-13.98	-6.56	-11.19	-10.63	-6.88	-1.76	-6.59	-13.38	-8.05	4.15
179	-5.09	-9.52	-19.23	-9.94	-14.62	-14.72	-11.11	-3.87	-9.78	-17.36	-11.52	4.98
180	-5.41	-8.45	-14.74	-8.91	-10.87	-14.74	-10.27	-3.60	-8.60	-14.80	-10.04	3.89
181	-4.77	-7.03	-14.49	-7.79	-11.46	-14.71	-9.84	-2.82	-7.82	-16.29	-9.70	4.48
182	-6.33	-6.05	-12.84	-9.29	-9.63	-17.44	-12.73	-4.61	-10.03	-17.49	-10.64	4.49
183	-4.83	-7.15	-13.64	-7.58	-10.53	-17.04	-10.94	-3.85	-9.46	-18.40	-10.34	4.86
184	-7.12	-6.10	-12.36	-9.63	-11.45	-18.39	-13.52	-4.81	-9.69	-19.31	-11.24	4.86
185	-6.86	-4.50	-12.08	-11.79	-14.11	-23.71	-14.96	-4.22	-11.21	-21.15	-12.46	6.46
186	-6.65	-3.73	-14.60	-10.37	-16.20	-23.18	-15.41	-3.47	-12.23	-26.80	-13.27	7.72
187	-9.16	-5.85	-16.98	-9.97	-11.92	-21.77	-15.08	-6.15	-10.90	-19.62	-12.74	5.45
188	-8.69	-5.47	-14.61	-9.91	-10.35	-22.90	-16.24	-5.41	-12.63	-23.03	-12.92	6.34
189	-6.54	-4.93	-12.36	-8.56	-8.15	-20.17	-14.02	-4.45	-11.29	-18.44	-10.89	5.42
190	-7.34	-4.73	-12.92	-10.03	-14.40	-25.98	-15.79	-4.17	-10.24	-28.32	-13.39	8.21
191	-6.93	-4.00	-13.75	-10.33	-17.19	-25.76	-14.76	-3.89	-11.51	-31.14	-13.93	8.91
192	-9.55	-5.42	-19.63	-13.64	-22.33	-30.90	-18.12	-5.95	-13.07	-34.32	-17.29	9.82
193	-9.86	-5.90	-22.57	-15.70	-21.28	-30.51	-20.39	-5.65	-16.56	-32.04	-18.05	9.21
194	-10.40	-5.63	-20.82	-16.09	-22.95	-30.98	-20.25	-6.86	-14.54	-34.65	-18.32	9.62
195	-9.56	-7.01	-18.53	-14.60	-21.54	-29.87	-21.29	-5.95	-14.46	-32.97	-17.58	9.12
196	-9.95	-4.17	-17.52	-14.26	-20.69	-30.68	-19.61	-5.03	-13.66	-29.74	-16.53	9.09
197	-8.73	-3.89	-16.79	-12.26	-19.06	-27.11	-17.83	-5.72	-13.64	-30.73	-15.58	8.67
198	-9.25	-5.11	-16.97	-13.06	-17.73	-26.57	-20.78	-5.55	-14.23	-29.80	-15.90	8.26
199	-9.25	-4.27	-16.80	-11.66	-17.56	-24.87	-18.82	-5.50	-14.11	-27.73	-15.06	7.70

Station	Year										10-Year	
	1	2	3	4	5	6	7	8	9	10	Ave	Std
200	-9.76	-4.93	-19.32	-13.68	-19.32	-23.97	-18.57	-5.75	-13.86	-33.45	-16.26	8.64
201	-9.14	-6.26	-17.42	-13.46	-19.15	-23.53	-17.92	-6.26	-14.29	-28.39	-15.58	7.23
202	-8.66	-4.24	-14.03	-13.18	-17.81	-23.99	-18.49	-5.47	-12.74	-28.35	-14.70	7.70
203	-9.00	-3.42	-13.58	-12.41	-16.79	-22.70	-16.90	-4.84	-13.89	-25.28	-13.88	7.01
204	-9.64	-3.49	-12.86	-13.62	-15.99	-23.92	-19.08	-5.08	-13.07	-25.89	-14.27	7.30
205	-9.53	-1.86	-13.17	-13.12	-16.03	-22.52	-17.98	-4.40	-13.06	-25.13	-13.68	7.28
206	-9.26	-3.68	-16.34	-13.32	-19.16	-21.06	-16.86	-4.28	-12.25	-25.95	-14.22	7.15
207	-10.55	-6.77	-16.72	-15.37	-19.30	-25.64	-19.16	-7.37	-16.45	-27.41	-16.47	6.93
208	-9.95	-3.34	-15.67	-14.47	-18.11	-26.06	-19.63	-5.67	-15.42	-27.83	-15.61	7.91
209	-10.27	-2.15	-14.21	-16.34	-17.79	-26.99	-20.06	-5.87	-16.17	-27.96	-15.78	8.26
210	-12.94	-5.60	-19.25	-20.93	-21.79	-31.04	-23.80	-8.26	-20.55	-30.46	-19.46	8.45
211	-13.58	-5.49	-20.84	-17.30	-21.00	-31.15	-24.12	-6.98	-18.55	-31.45	-19.05	8.79
212	-13.10	-4.07	-16.25	-17.67	-21.22	-30.15	-24.73	-6.43	-17.61	-33.14	-18.44	9.34
213	-14.74	-6.21	-20.18	-20.83	-24.81	-33.14	-27.29	-7.69	-20.97	-36.35	-21.22	9.85
214	-15.61	-5.32	-20.83	-23.28	-23.70	-34.71	-27.06	-9.03	-21.54	-36.66	-21.78	9.97
215	-17.17	-6.72	-25.78	-26.85	-27.68	-40.60	-31.95	-10.66	-27.06	-42.04	-25.65	11.52
216	-18.68	-8.08	-25.09	-27.12	-29.60	-43.91	-34.64	-9.90	-29.14	-45.05	-27.12	12.49
217	-20.86	-9.63	-28.41	-29.35	-31.81	-46.58	-36.74	-13.74	-28.39	-47.26	-29.28	12.40
218	-20.22	-9.10	-27.81	-28.55	-32.02	-45.73	-37.90	-11.58	-29.13	-48.48	-29.05	13.02
219	-20.20	-9.36	-29.60	-27.79	-31.19	-45.76	-36.95	-11.40	-29.67	-45.44	-28.74	12.44
220	-20.37	-9.46	-29.62	-31.27	-35.12	-48.40	-39.37	-13.60	-31.10	-51.32	-30.96	13.68
221	-21.58	-9.38	-29.52	-29.22	-34.65	-49.05	-39.76	-12.44	-31.17	-52.68	-30.95	14.11
222	-25.13	-12.22	-33.59	-31.65	-33.24	-52.72	-41.86	-14.98	-34.16	-47.98	-32.75	12.97
223	-23.74	-11.52	-29.98	-30.11	-30.90	-49.78	-41.59	-14.45	-31.84	-45.71	-30.96	12.43
224	-20.91	-8.90	-24.50	-25.24	-25.86	-42.63	-35.76	-10.41	-27.31	-37.25	-25.88	10.87
225	-21.31	-10.69	-28.03	-27.12	-30.73	-42.53	-35.67	-13.24	-28.66	-42.85	-28.08	10.86
226	-19.97	-8.87	-25.46	-23.78	-28.48	-40.64	-34.36	-10.71	-27.51	-42.53	-26.23	11.23
227	-21.17	-9.43	-27.23	-23.66	-29.41	-40.41	-34.26	-12.52	-26.84	-40.62	-26.56	10.46
228	-21.74	-9.91	-26.72	-24.68	-27.61	-39.95	-35.56	-12.42	-28.27	-37.32	-26.42	9.91
229	-19.42	-9.32	-24.07	-25.12	-26.55	-38.21	-32.65	-11.58	-25.79	-35.39	-24.81	9.44
230	-18.73	-9.02	-25.25	-24.53	-26.42	-38.16	-31.86	-12.41	-25.58	-34.96	-24.69	9.28
231	-18.05	-8.73	-22.98	-23.66	-25.45	-35.93	-30.36	-11.96	-25.08	-33.94	-23.61	8.81
232	-17.78	-7.77	-23.93	-22.89	-24.70	-34.67	-29.44	-11.96	-23.99	-32.29	-22.94	8.50
233	-17.15	-7.62	-21.94	-22.40	-25.93	-33.00	-29.28	-10.69	-23.77	-32.33	-22.41	8.54
234	-18.53	-8.22	-23.81	-22.10	-26.46	-34.04	-29.77	-11.58	-23.42	-33.84	-23.18	8.61
235	-20.15	-9.84	-26.30	-23.83	-26.33	-34.29	-31.71	-13.31	-26.28	-32.40	-24.44	8.02
236	-18.63	-9.84	-24.18	-20.43	-23.88	-31.37	-28.93	-11.28	-24.81	-30.72	-22.41	7.48

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# REPORT DOCUMENTATION PAGE

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<b>1. REPORT DATE (DD-MM-YYYY)</b> September 2008		<b>2. REPORT TYPE</b> Final report		<b>3. DATES COVERED (From - To)</b>	
<b>4. TITLE AND SUBTITLE</b> Wave Climate and Littoral Sediment Transport Study for Virginia Beach, VA - Rudee Inlet to Cape Henry, Hydraulic Model Study				<b>5a. CONTRACT NUMBER</b>	
				<b>5b. GRANT NUMBER</b>	
				<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>6. AUTHOR(S)</b> Michael J. Briggs and Edward F. Thompson				<b>5d. PROJECT NUMBER</b>	
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				<b>5f. WORK UNIT NUMBER</b> LGF20L	
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<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> U.S. Army Engineer District, Norfolk 803 Front Street Norfolk, VA 23510				<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>	
				<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>	
<b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b>  Approve for public release; distribution is unlimited.					
<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b>  The Norfolk District is preparing an Environmental Assessment for the use of sand sources off the coast of Cape Henry for future maintenance of the Virginia Beach, VA, shoreline. The primary purpose is to maintain a buffer for hurricane protection for structures landward of the existing beach. The Cape Henry Borrow Area is being considered as a sand source. The plan borrow scenario involves removing approximately 34.2 M cu yd of material from the borrow area over a period of 50 years. The study provided wave climate and potential longshore transport information and analysis for two bathymetric cases: existing bathymetry and planned excavation from the Cape Henry Borrow Area. These two cases bracket the range of expected conditions over the next 50 years and enable assessment of potential project impacts on littoral transport patterns along adjacent beaches during this time frame.					
<b>15. SUBJECT TERMS</b>		50 year time period	Littoral transport patterns	Wave climate	
Cape Henry Borrow area		Hurricane protection	Sand sources		
Environmental assessment		Littoral sediment transport	Virginia Beach		
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>	<b>19a. NAME OF RESPONSIBLE PERSON</b>
<b>a. REPORT</b>	<b>b. ABSTRACT</b>	<b>c. THIS PAGE</b>			<b>19b. TELEPHONE NUMBER (include area code)</b>
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