the accumulation of the sediment on the channel bottom. A schematic sketch of the model and the definition of terms used in the model are shown on Figure 6.3. Relocation of the Bogue Inlet channel will require an ocean certified pipeline dredge. The production rate for these type dredges depends on the total length of pipeline used for disposal but generally ranges from 1,300 cubic yards/hour for relatively long pipeline lengths to around 1,500 cubic yards/hour for shorter lengths. For the channel closure, the pipeline length will average around 4,000 feet, therefore production rates approaching 1,500 cubic yards/hour would be expected. For this estimate, however, the production rate of the dredge (Q_{in}) was assumed to be 900 cubic yards/hour or 60% of the maximum production rate. The characteristics of the material that would be pumped from the new channel to construct the dike are given in Table 6.1 and are based on the composite analysis of the vibracore samples.

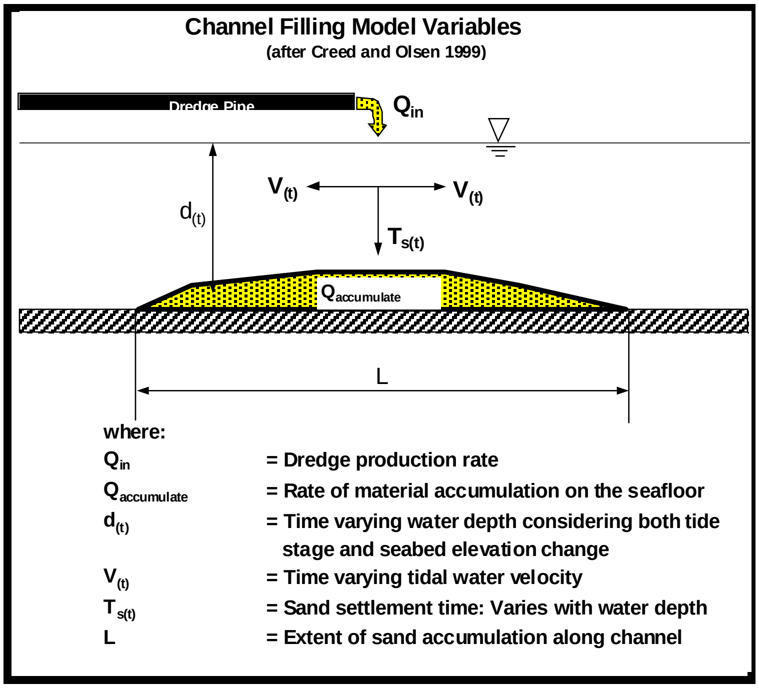

Figure 6.3 Definition Sketch for Channel Closure Model

Table 6.1
Distribution of Grain Sizes From New Channel

Size Range (mm)	Average d in size range (mm)	Percent of Distribution
d > 4	4	1.54
4 to 2	3	1.29
2 to 1	1.5	2.82
1 to 0.5	0.75	8.97
0.5 to 0.25	0.375	34.07
0.25 to 0.125	0.188	49.50
0.125 to 0.062	0.094	0.56
d < 0.062 (silt)	0.055	1.25

6.5. The computation of the dredged quantity needed to construct the dike was based on the fall velocity of a particle size of 0.188 mm, which is the median grain size (d_{50}) of the material. Estimates will be provided later on the concentration and areal extent over which the silt content of the dredged material will be dispersed during the operation. The fall velocity of the 0.188 mm particle size was determined from equations and charts provided in Chapter 4 of the Corps of Engineers Shore Protection Manual (USACE 1984) for a concentration of particles coming out of the dredge pipe. As a matter of note, the fall velocity of a particle in a concentration is much slower than the fall velocity of an individual particle due to turbulent interaction between the particles. The concentration fall velocity (V_{fc}) for the 0.188 mm particle size used in the analysis was determined to be 0.043 fps. The amount of time required for the sand to settle to the bottom ($T_{s(t)}$) is a function of the time varying depth (d_t) and is equal to d_t/V_{fc}. The distance the sand would travel before settling to the bottom depends on the current velocity ($V_{(t)}$) in the channel at any given time and is determined by:

$$L_t = (d_t/V_{fc}) \times V_t$$

6.6. Flow velocities (V_t) used in the dike model were based on the results of the numerical model, which determine flows in the channel for the base condition and for the case when the dike was midway through construction. The velocity curves for these two conditions are shown on Figure 6.4. As the dredged material falls through the water column under varying current and tide conditions, it is distributed over a wide area both landward and seaward of the dike centerline. Computations of the change in the crest elevation of the dike proceeded in a stepwise manner in which the volume of material deposited in the channel over a given time increment was divided by the surface area over which the material would be distributed. The deposition surface area is equal to $L_t \times W_{ave}$ (average channel width). The average width of the channel used in the model was 1,200 feet, which is approximately equal to the width of the channel at mid depth.

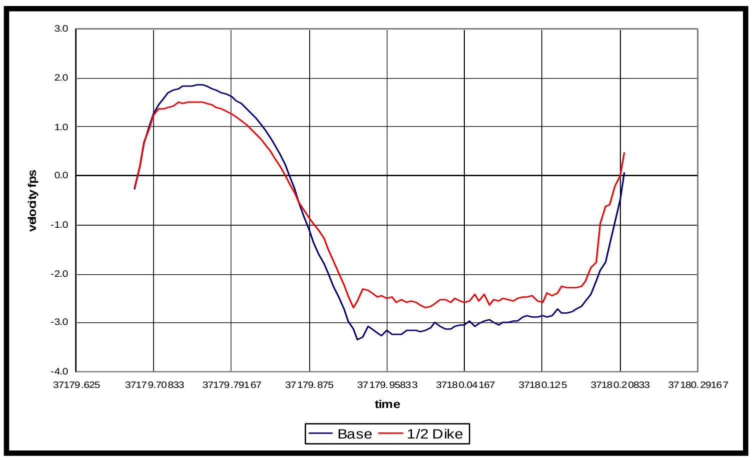

Figure 6.4 Model Velocities in Existing Channel for Base Condition and Dike 50% Complete

6.7. Model Predictions. The computations were carried out until the crest elevation of the dike reached an elevation equal 2.5 feet above NGVD or slightly above mean high water. Once the dike reaches this elevation, no flow would occur across the dike and the elevation of the dike could be raised to +4.5 feet NGVD without the interference of the tidal currents. The total construction time determined from the application of the model was 6.5 days with the volume of material required to raise the dike to an elevation of +2.5 ft NGVD equal to 141,200 cubic yards. An additional 8,100 cubic yards would be needed to raise the crest elevation of the dike to +4.5 feet NGVD resulting in a total volume of 148,500 cubic yards. As noted above, the actual volume and time required to close the channel in Port Royal Sound was about 31% greater than predicted. Accordingly, the model results for the Bogue Inlet dike were increased by about 35% resulting in a design volume of 200,000 cubic yards. For the assumed dredge production rate of 900 cubic yards/hour, the total construction time for the dike would be 9.5 days. Figure 6.5 provides a plot of the time varying cross-sectional area of the existing channel during the closure operation. A typical cross-section of the dike is shown on Figure 6.6. The volume and time required to construct the dike are considered to be very conservative given the assumed production rate of the dredge was only 60% of its normal production rate and the final quantities were increased by 35%.

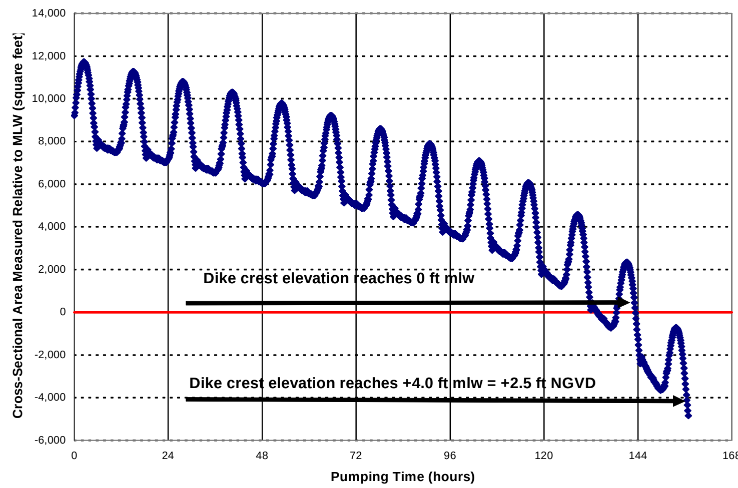

Figure 6.5 Change in Cross-Sectional Area of Existing Channel During Closure

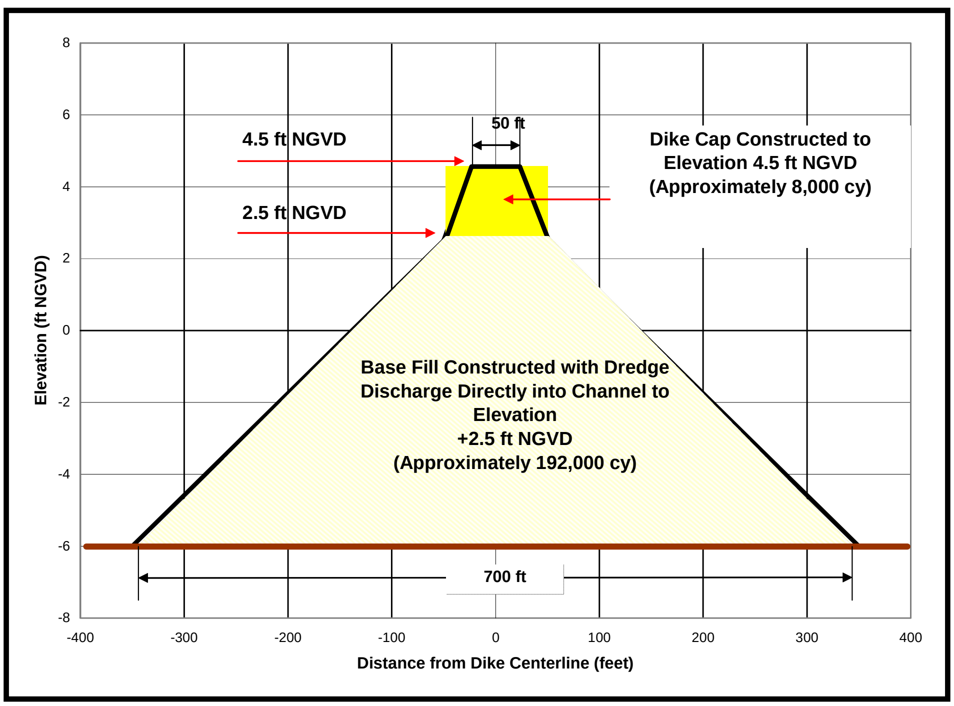

Figure 6.6 Typical Cross-Section of Dike

.8. Logistics of the Dike Construction. Closure of the existing channel cannot start until the new channel has been advanced to the point that it begins to carry a significant portion of the flow through the inlet. In this regard, a plot of the cumulative dredge volume for the 13.5-ft NGVD x 500 ft channel is shown on Figure 6.7 with the cumulative amount determined from the ocean into the sound. The channel centerline station where the volume remaining to be dredge is equal to 200,000 cubic yards is 23+00. The station where pumping into the existing channel would begin is located in the existing ebb channel that swings past Island 2 (Figure 6.1). Therefore, the new channel would be completely open to the sea while the construction of the channel is completed across the shoals located between Island 2 and the Bogue Banks sand spit.

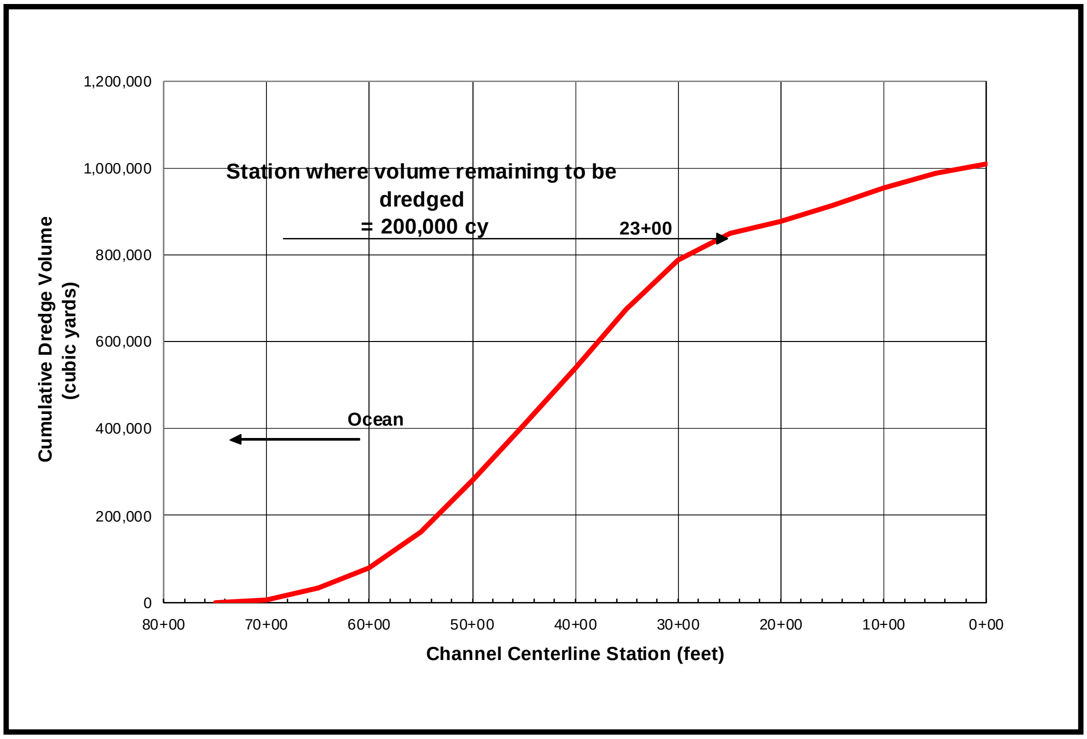

Figure 6.7 Cumulative Dredge Volume for 13.5-ft NGVD x 500 ft Channel

6.9. Dispersion of Silt. As the channel material is discharged into the existing channel to construct the dike, the silt will go into suspension and will be carried toward the sound and toward the ocean during each phase of the tidal cycle. Due to its small particle size, the silt will be transported a considerable distance before it eventually settles to the bottom. The travel distance of the silt during the construction of the dike was computed in the same manner as the sand particles. For grain sizes less than 0.062 mm (silt), the representative concentration fall velocity used in the analysis was 0.004 fps, which is the concentration fall velocity for a particle size of 0.055 mm. Over a complete tidal cycle, the horizontal fall distance for the silt was estimated to be around 3,500 feet during flood and 4,500 feet during ebb. The areal extent of the suspended sediment plume is indicated on Figure 6.1. The percent of the material to be removed to relocate the channel has an average silt content of 1.25%. Therefore, for a dredge production rate of 900 cubic