Development of Methodology for Thirty-Year Shoreline Projections in the Vicinity of Beach Nourishment Projects

December 15, 1989

Prepared for:

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DEVELOPMENT OF METHODOLOGY FOR THIRTY-YEAR SHORELINE PROJECTIONS IN THE VICINITY OF BEACH NOURISHMENT PROJECTS

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INTRODUCTION

The purpose of this report is to develop and illustrate with examples readily applied methodologies for calculating the response of shorelines in the vicinity of beach nourishment projects. The need for such methodology is a result of Florida Statutes 161.053(G) and Rule 16B-33.024(3)(e) which require, with minor exceptions, coastal structures to be located landward of a thirty- year projection of the Seasonal High Water Shoreline (SHWL).

The conceptual interpretation of these Statutes and Rule is that the performance of the beach nourishment project should be considered in projecting the Seasonal High Water Line (SHWL) position to a time thirty years into the future. This requires consideration of both the background erosion rate which is the normal rate in areas that have not been nourished and the shoreline retreat component due to "spreading out" losses from the beach nourishment project.

BACKGROUND

General Description of Sediment Transport Processes in the Vicinity of a Beach Nourishment Project

In general, when sand is placed in conjunction with a beach nourishment project, this project represents an "anomaly" to the shoreline planform and the natural processes will tend to smooth out this anomaly. In addition, many times the placed profile will be steeper than the natural profile and the profile will tend to equilibrate over time. The sections below describe the individual processes and characteristics of the response of a beach nourishment project.

Profile Equilibration

As noted, beach nourishment projects are generally placed with profiles which are steeper than the natural profile for the size of sediment that is used in the beach nourishment project. Thus over the years this profile will tend to equilibrate to its natural shape. In addition, if the sediment size used in the beach nourishment is fine, the profile will tend to be rather mild in slope and the shoreline advancement will be small for a given volume of beach nourishment per unit length of beach. Figure 1 shows the qualitative effect of grain size in terms of the dry beach width for the same added volume per unit length of beach. The upper panel presents the profile that would result for a beach nourishment grain size which is larger than the native sand resulting in a fairly wide dry beach width. The three lower panels illustrate the effect of decreasing grain size maintaining the volume per unit beach length the same. It is seen that with decreasing grain size the dry beach width progressively decreases to a point where in the lower panel the dry beach width is zero. For this condition all of the sand that has been placed has been moved offshore in a profile which is consistent with the grain size used in the nourishment.

"Spreading Out" Losses

The placement of a beach nourishment project results in a planform anomaly which interacts with the waves to result in sediment transport away from this anomaly. This process is illustrated in Figure 2 and shows the transport occurring away from the anomaly in a manner that will result in a smoothing or spreading out of the sediment. The term "spreading out" losses actually refers to a redistribution of the sediment and not a total loss to the system but rather a loss from the region in which the sediment is placed. As will become evident later, this loss from the nourished area is manifested as a gain of sediment volume in the nourishment-adjacent areas.

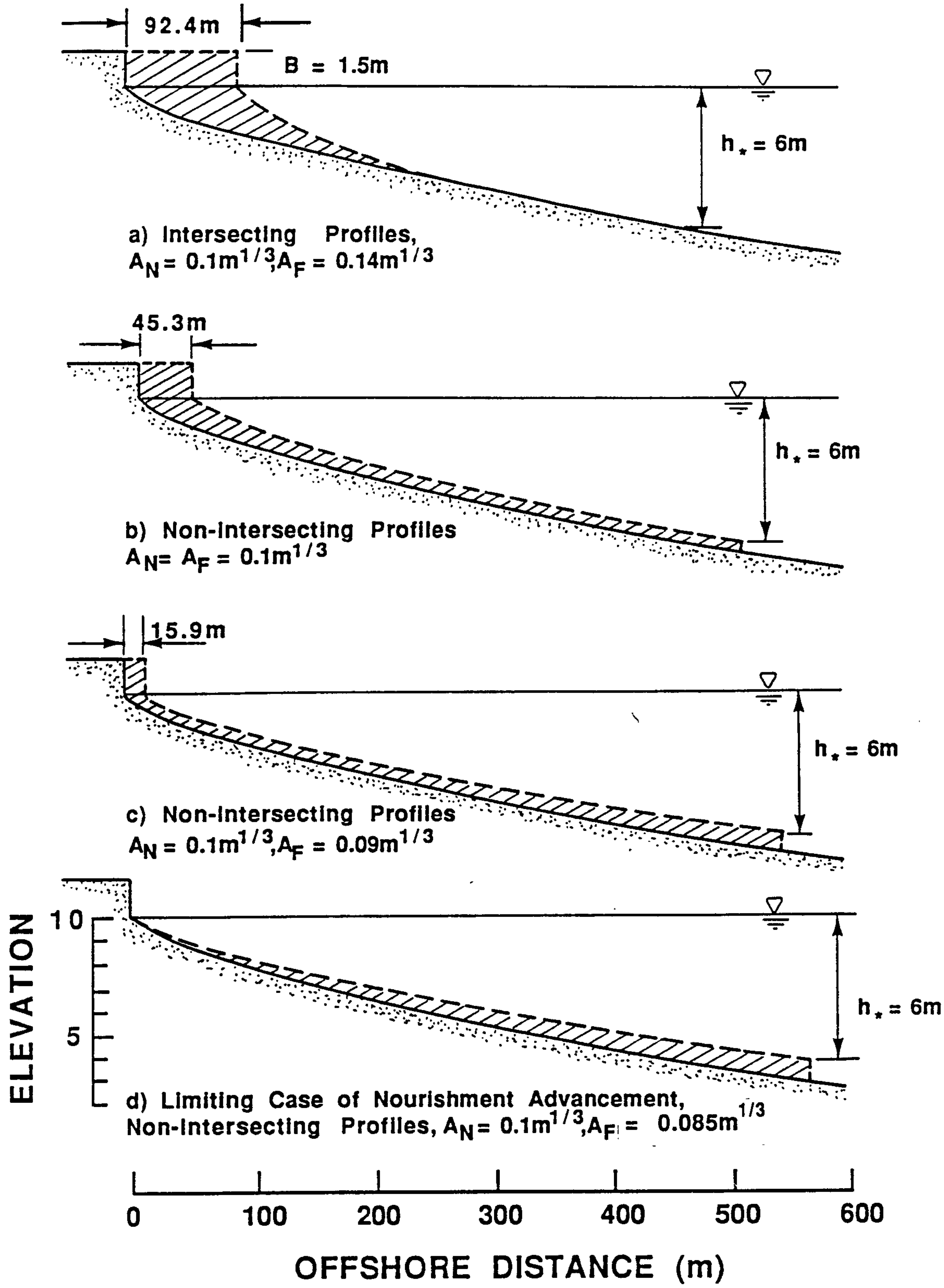


Figure 1. Effect of Nourishment Material Scale Parameter, A_F, on Width of Resulting Dry Beach. Four Examples of Decreasing A_F.

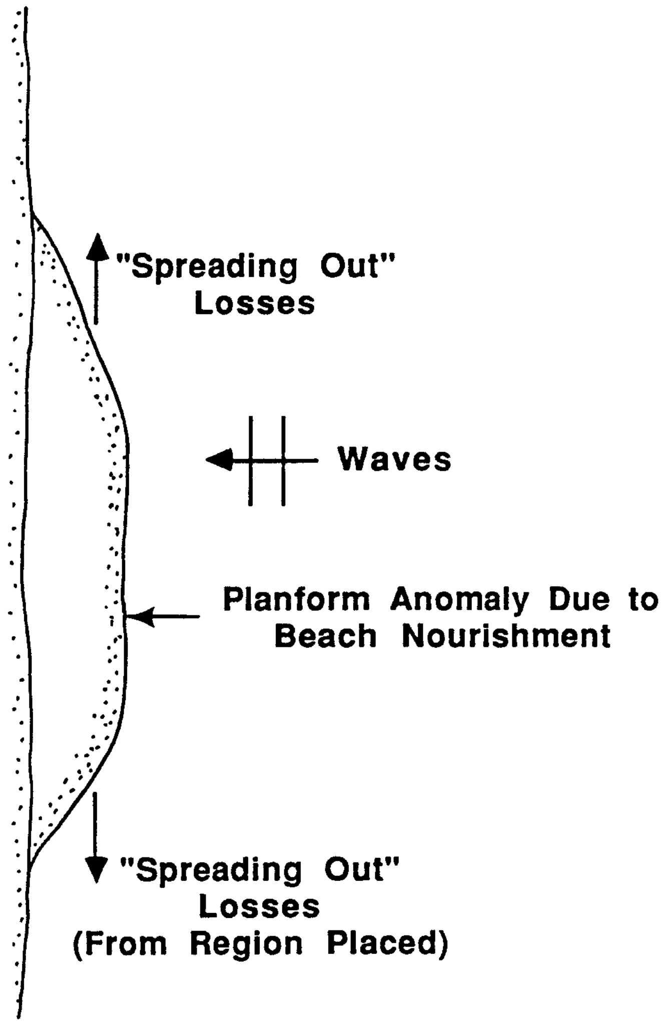


Figure 2. "Spreading Out" Losses Occurring Due to Mobilization of Sediments by Waves.

Background Erosion

Usually the need for a beach nourishment project is due to a background erosion which, for an ideal project, is relatively slow. With the placement of the beach nourishment project, there will be two components of shoreline retreat. It will be assumed that the two components of shoreline recession, i.e. background erosion and the component due to spreading out losses, can be added linearly. The background erosion which was present prior to the placement of the beach nourishment project will continue. Figure 3 illustrates qualitatively the superposition of these two components for several locations within and adjacent to a beach nourishment project. Figure 3a presents the case for no background erosion and Figure 3b for a uniform background erosion of 2 ft/yr.

Role of Retention Structures

In some cases, especially short beach nourishment projects, it may be worthwhile to consider the use of retention structures to extend the life of the projects. Figure 4 illustrates qualitatively one such application. Structures must be used with great care, especially in areas where there is a substantial longshore transport magnitude. An additional situation in which retention structures have been used effectively to prevent loss of sediment in Florida has been at the ends of littoral systems such as at the termini of barrier islands. Two such locations are the north jetty at John's Inlet in Pinellas County and the two small terminal structures at the south end of Gasparilla Island in Lee County.

Role of Sediment Size on Transport Rates

It has been noted that the dominant losses due to a beach nourishment project are due to spreading out losses or transport away from the region where the sediment is placed. The sediment transport is proportional to a coefficient, K, which has been found to depend on sediment size as shown in Figure 5; thus with the use of coarser grained material, the project will perform much more effectively. Although there has not been any substantial documentation to illustrate adverse effects of using material which is substantially coarser

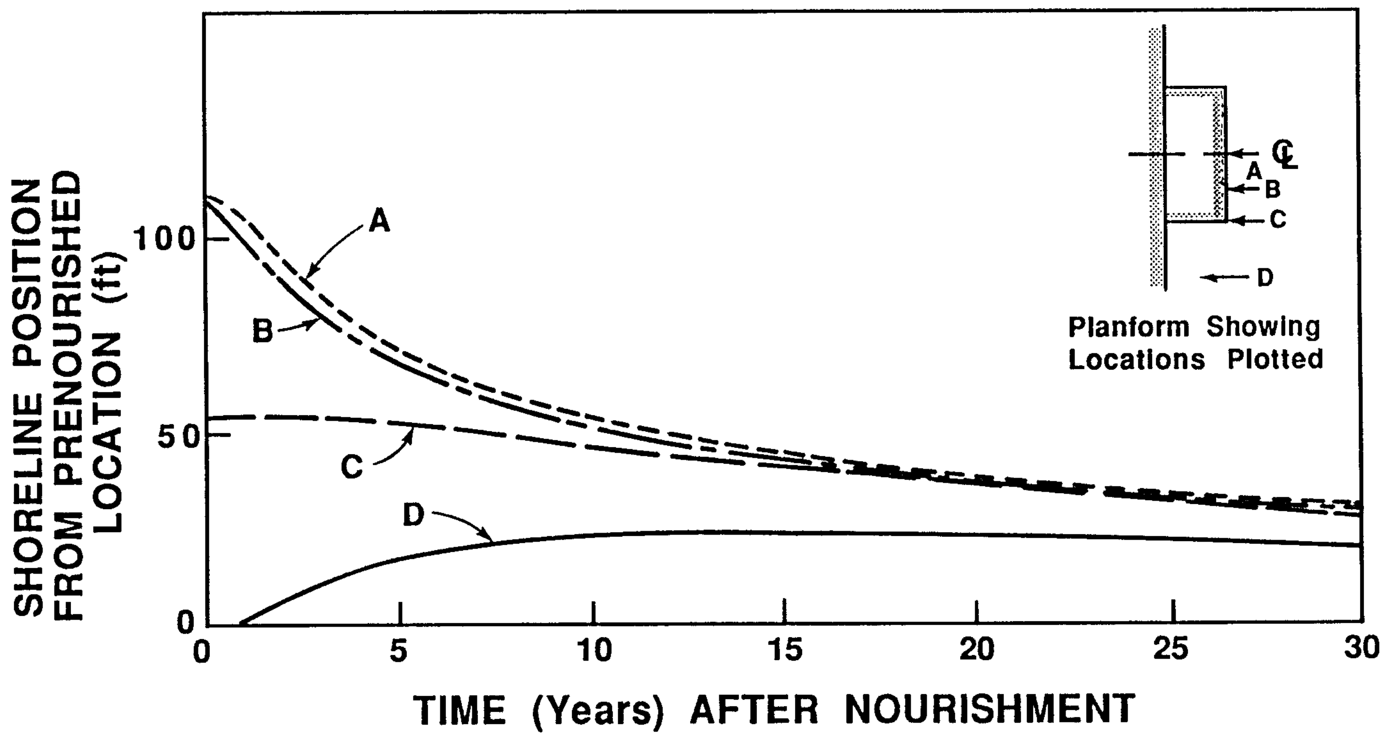


Figure 3a. Variation of Shoreline Position with Time at Various Locations Relative to a Nourishment Project. No Background Erosion.

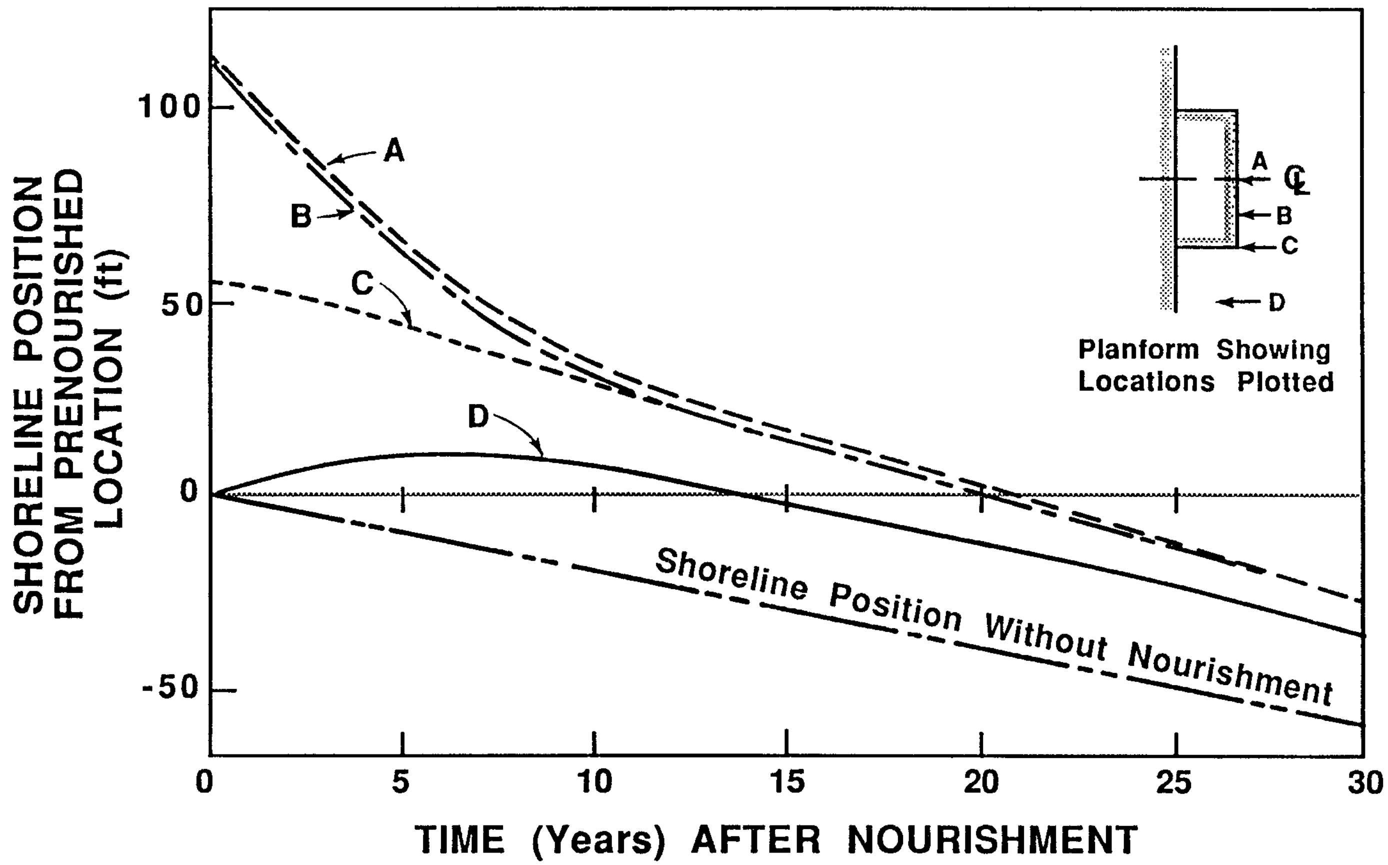


Figure 3b. Variation of Shoreline Positions with Time at Various Locations Relative to a Nourishment Project. Uniform Background Erosion of 2 ft/yr.

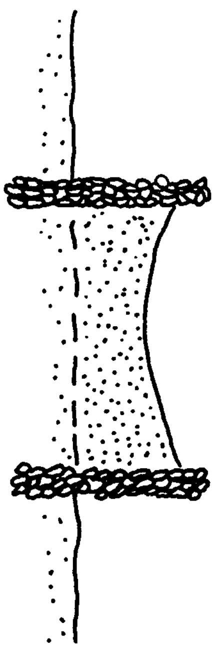


Figure 4. Illustration of Nourishment Stabilization by Terminal Structure.

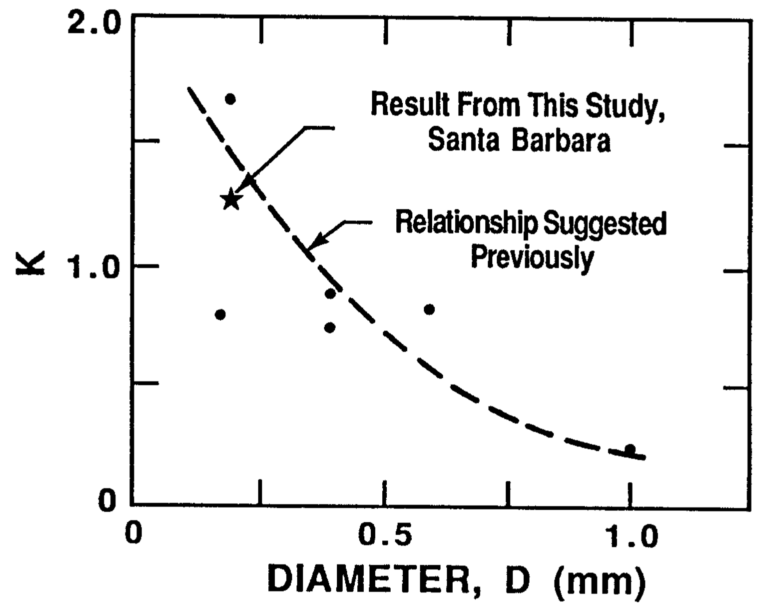


Figure 5. Plot of K vs. D. Results of Present and Previous Studies (modified from Dean, 1978).

than the native material, it has been hypothesized that if such material is used it may effectively armor the beach in the nourishment area thereby resulting in less transport from the area nourished and a deficit and associated erosion on the area downdrift of the project.

Significance of Wave Height

After placement of a beach nourishment project, it is evident intuitively that the mobilizing effects of wave height cause profile equilibration and the spreading out losses mentioned earlier. Thus the determination of reliable, effective wave heights is important to the prediction of the performance of any beach nourishment projects.

As will be described later, for two identical projects which are placed in areas where the wave height differs by a factor of two, the longevity of these projects would differ by a factor of 5.3.

Wave Direction

It is somewhat surprising that on a long, uninterrupted shoreline the effect of wave direction is relatively unimportant to the performance of a beach nourishment project. The interpretation of this insensitivity will be discussed in a later portion of this report. However, wave direction is extremely important in the case of a beach nourishment project located adjacent to a structure which interferes with the longshore sediment transport. Figure 6 illustrates such a situation where sand is placed immediately downdrift of a jetty and the orientation of the beach planform immediately adjacent to the jetty is parallel to the incident wave crests. Thus, it will be necessary to provide estimates of wave direction or to develop alternative methodologies which do not require accurate estimates of wave direction.

General Characteristics of Equilibrium Beach Profiles

In general, equilibrium beach profiles tend to be concave upward and the profiles tend to be milder in slope for the finer sediment and steeper for coarser sediment. Equilibrium beach profiles have been found by Bruun (1954) and Dean (1977) to be reasonably well

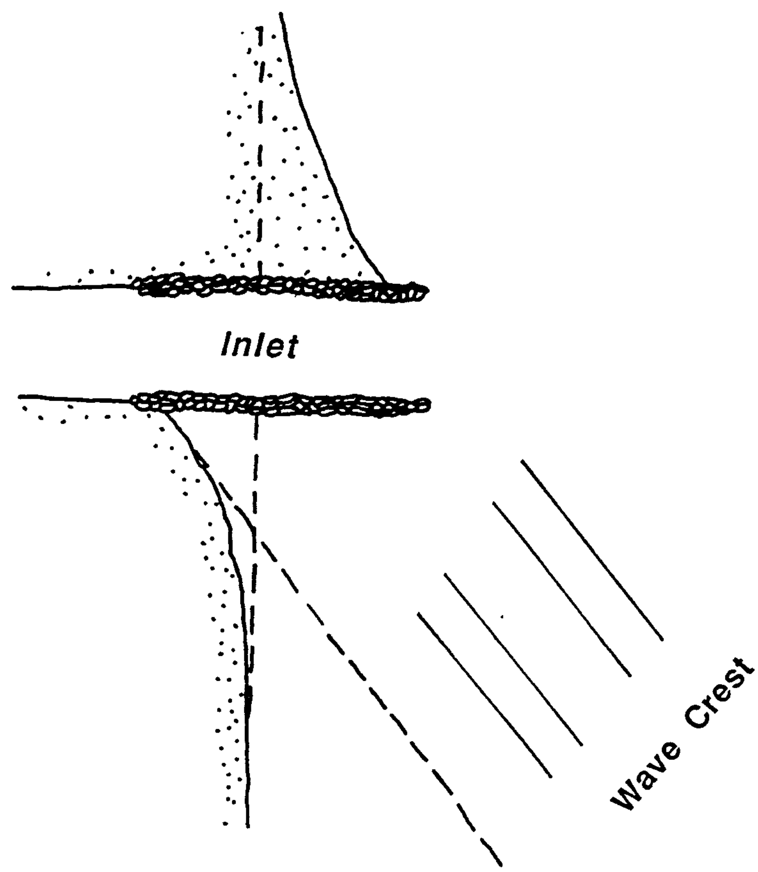


Figure 6. Shoreline Orientation Downdrift of a Complete Littoral Barrier.

represented by the form

$$h(y) = Ay^{2/3} \tag{1}$$

in which h is the depth at a distance y seaward of the shoreline and A is a scale parameter.

A significant contribution to the objectives of this report was developed by Moore (1982) in the form of a plot of the sediment scale parameter, A, in terms of the sediment size, Figure 7.

A second important relationship to the objectives of this study is that of closure depth, h_*. Closure depth is a concept which describes the maximum depth to which sediments will be mobilized by the waves. Although in general this closure depth is expected to be dependent on wave height and wave period, for purposes of this study, the closure depth will be regarded as a value dependent on position around the state of Florida. The recommended closure depth versus location around the state is presented in Figure 8.

METHODOLOGY

Profile Equilibration

In considering the profiles resulting from beach nourishment, generically there are three types of nourished, equilibrated profiles. These are presented in Figure 9. Referring to the top panel in this figure of intersecting profiles, a necessary but not sufficient requirement for intersecting profiles is that the fill material be coarser than the native material. One can see that an advantage of such a profile is that the nourished profile "toes in" to the native profile thereby negating the need for material to extend out to the closure depth.

The second type of profile is one that would usually occur in most beach nourishment projects. Nonintersecting profiles occur if the nourished material grain size is equal to or less than the native grain size. Additionally, this profile always extends out to the closure depth, h_*.

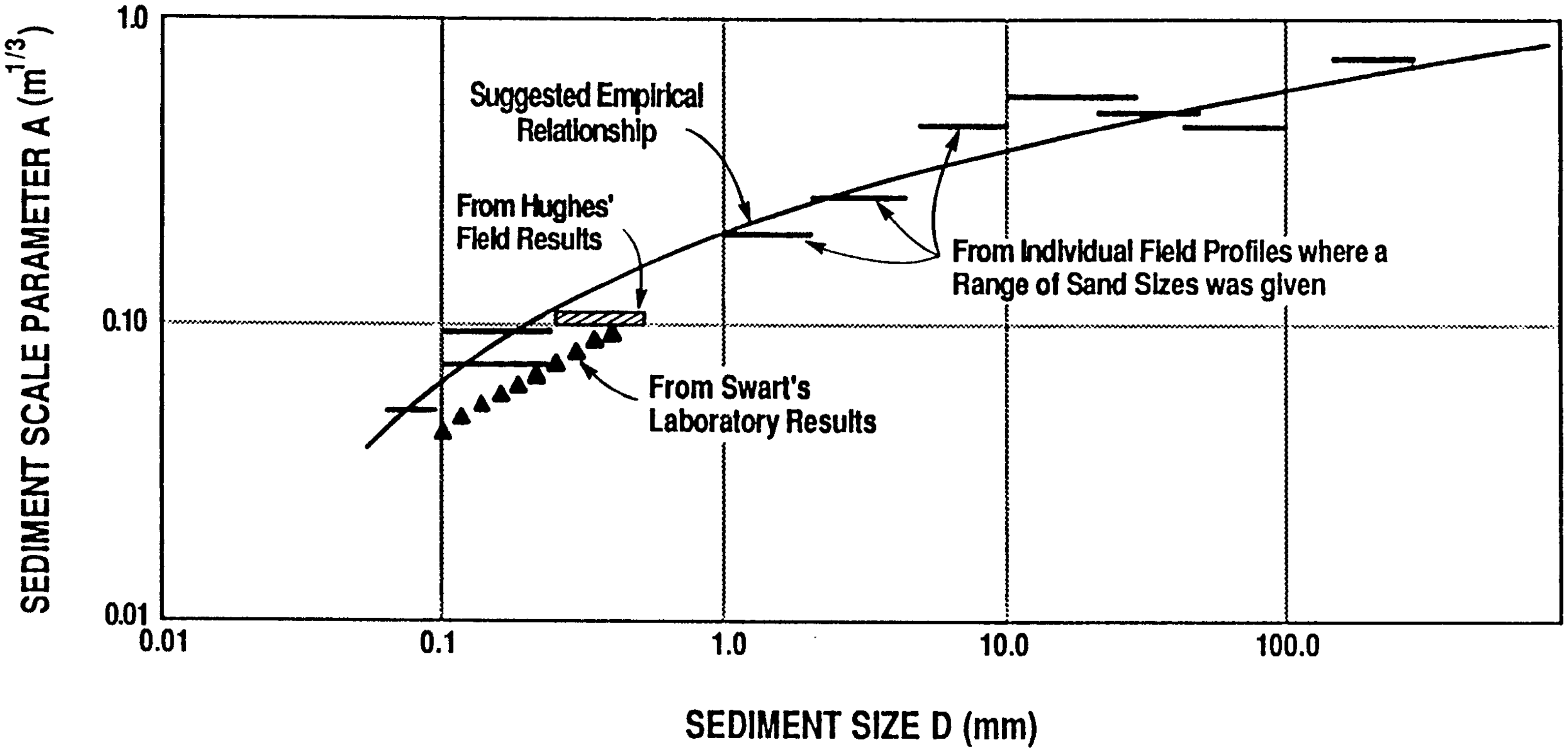


Figure 7. Beach Profile Factor, A, vs Sediment Diameter, D, in Relationship $h = Ay^{2/3}$ (modified from Moore, 1982). Note: $A(ft^{1/3}) = 1.5\ A(m^{1/3})$.

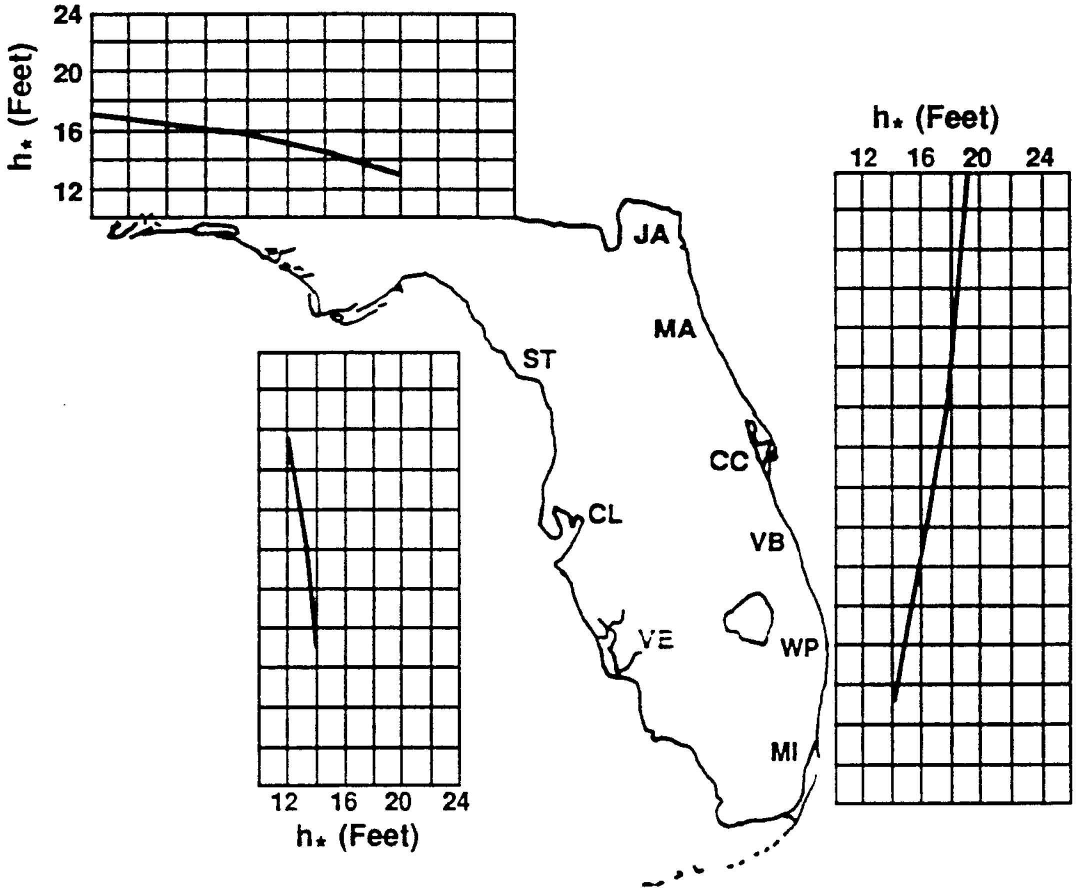


Figure 8. Recommended Distribution of h_* Along the Sandy Shoreline of Florida.

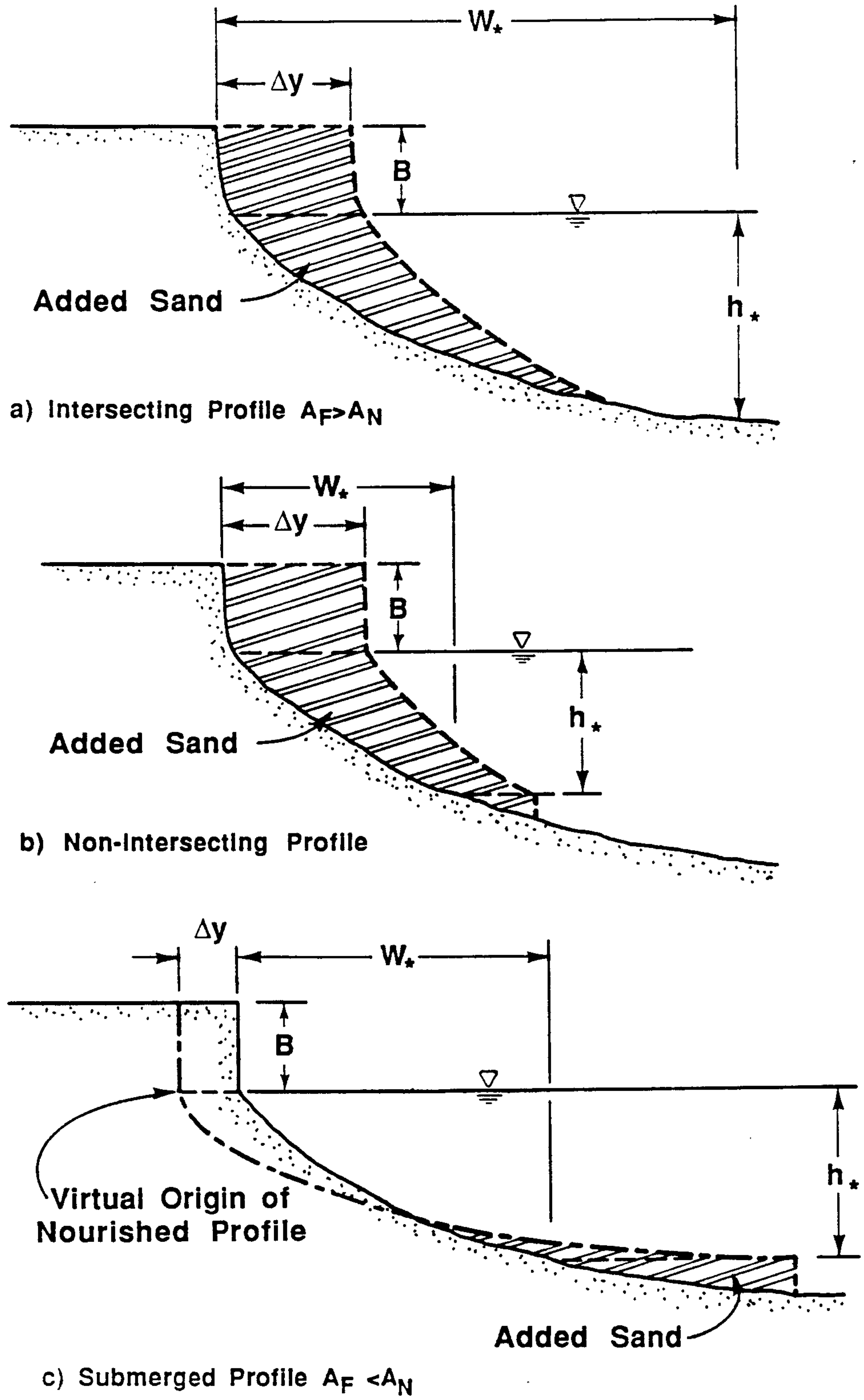


Figure 9. Three Generic Types of Nourished Profiles.

The third type of profile that can occur is the submerged profile (Figure 9c) the characteristics of which are shown in greater detail in Figure 10. This profile type requires the nourished material to be finer than the native. It can be shown that if only a small amount of material is used then all of this material will be mobilized by the breaking waves and moved offshore to form a small portion of the equilibrium profile associated with this grain size as shown in the upper panel. With increasing amounts of fill material, the intersection between the nourished and the original profile moves landward until the intersection point is at the water line. For greater quantities of material, there will be an increase in the dry beach width, Δy_0, resulting in a profile of the second type described.

The next major section describes the methodology for calculating planform response to a beach nourishment project. It is assumed that profile equilibration occurs when the material is placed. This assumption is not important to the final thirty year projection. Actually, of course the profile equilibration will occur gradually, but will probably be near completion within a few years. This assumption merely allows the overall response calculations to be carried out in two steps. Following the discussion of profile equilibration, graphical and numerical methods are presented for predicting the shoreline (planform) evolution. As might be expected the numerical method provides greater flexibility for representing realistically the actual situation.

It can be shown that the initial additional dry beach width, Δy_0, is related to the placed and native sediment characteristics and the closure depth, h_*, and berm height, B. To render the results more compact, the results are cast in the following non- dimensional form

$$\frac{\Delta y_0}{W_*} = f\left(A_F/A_N, \forall\, /BW_*, \frac{h_*}{B}\right) \tag{2}$$

in which W_* is the width of the active surf zone on the native profile, i.e.

$$W_* = (h_*/A_N)^{3/2} \tag{3}$$

Figures 11 and 12 present results of $\Delta y_0/W_*$ for h_*/B values of 2 and 4, respectively.

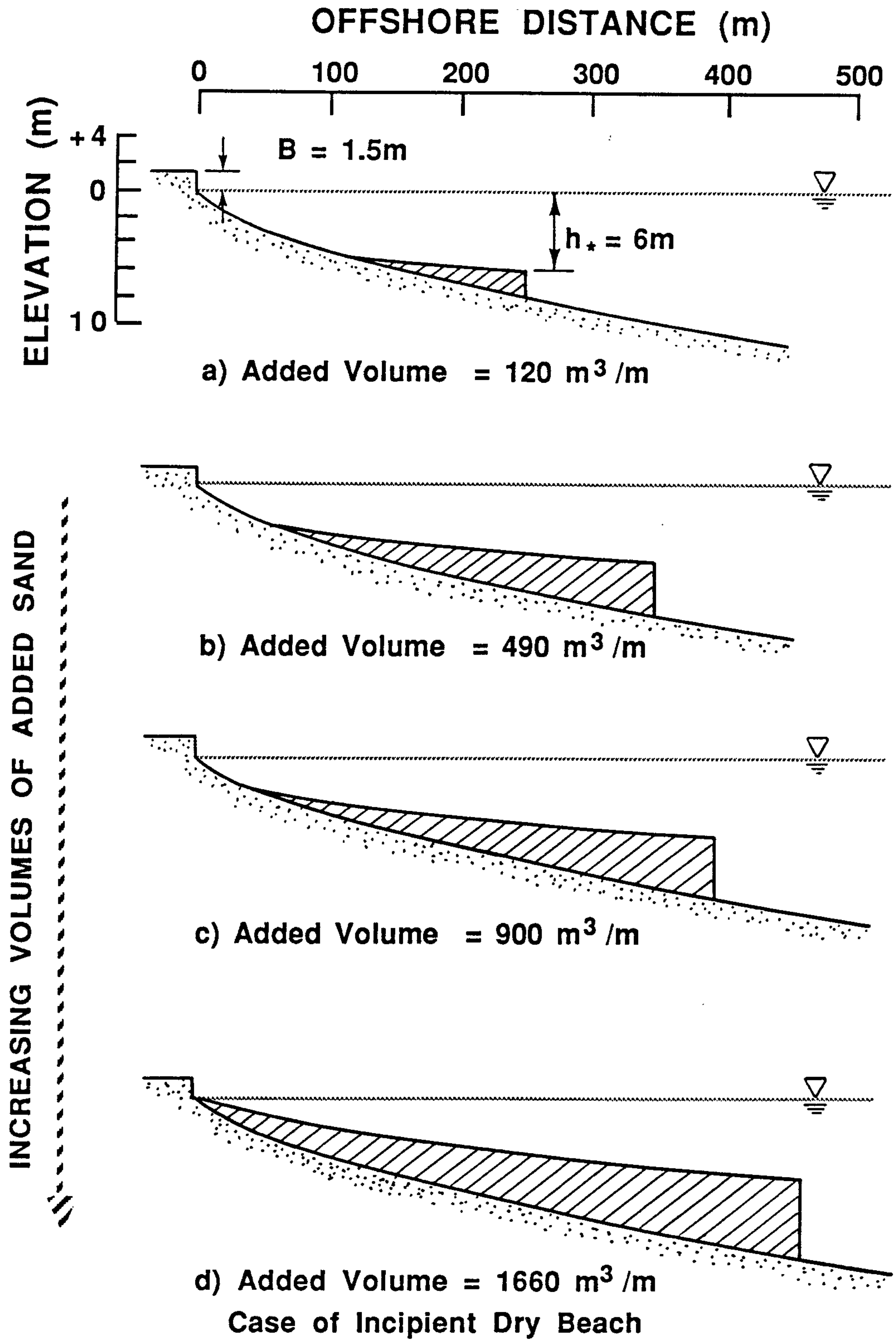


Figure 10. Effect of Increasing Volume of Sand Added on Resulting Beach Profile. $A_F = 0.1m^{1/3}$, $A_N = 0.2m^{1/3}$, $h_* = 6m$, B = 1m.

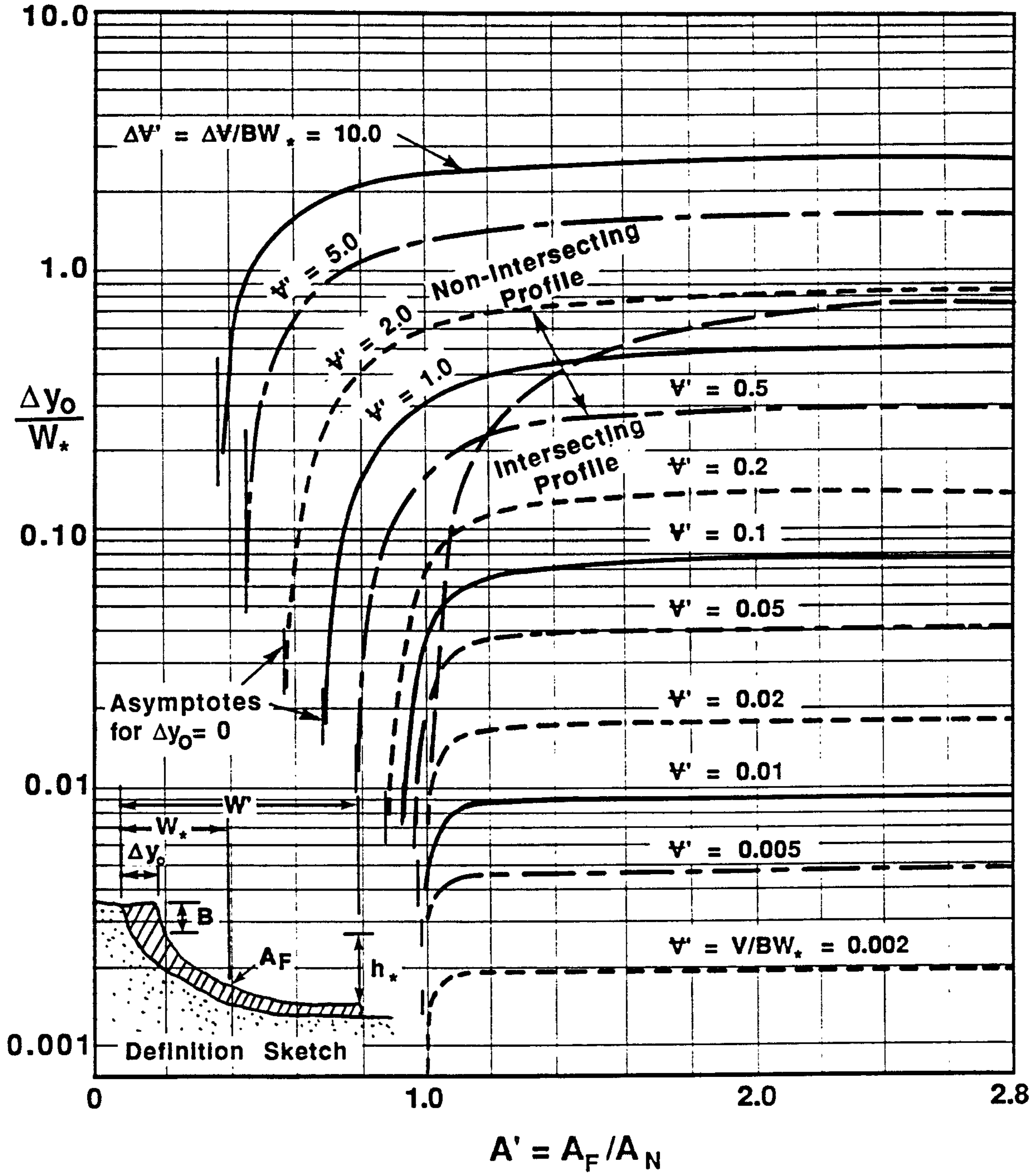


Figure 11. Variation of Non-Dimensional Shoreline Advancement $\Delta y_o/W_*$ with A' and V'. Results Shown for $h_*/B = 2.0$.

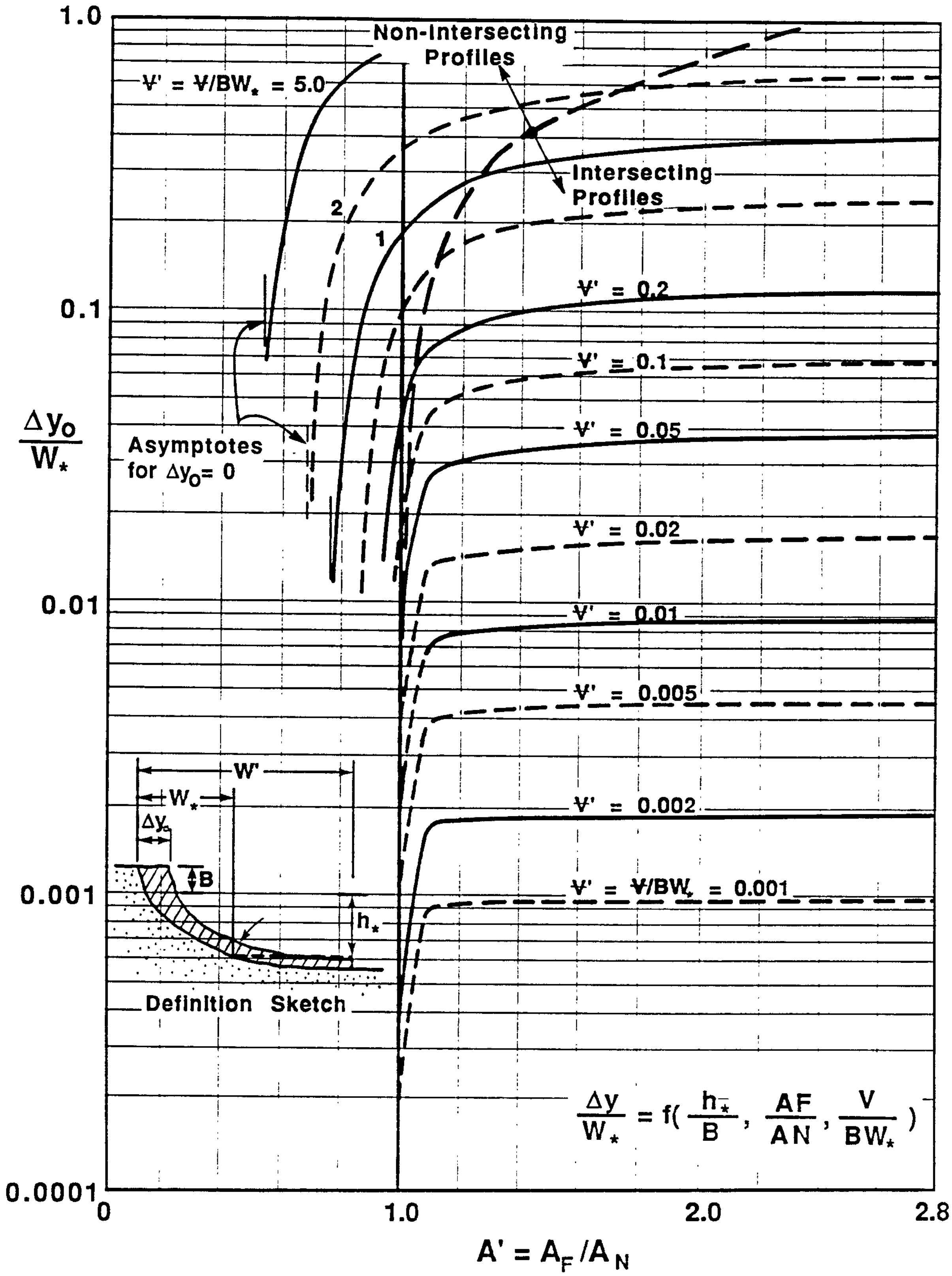


Figure 12. Variation of Non-dimensional Shoreline Advancement $\Delta y_0/W_*$, with A' and Ꝟ'. Results shown for $h_*/B = 4.0$.

It is seen that for each non- dimensional volume, the non-dimensional additional beach width increases with increase in ratio of sediment scale parameters; however, the increase is relatively small for ratios greater than 1.2. Additionally, there is some lower ratio of scale parameters for each non-dimensional volume below which there will be no additional dry beach width. This corresponds to the case presented in Figure 1d. As noted previously, the profile equilibrations will be assumed to occur instantaneously. The stage is now set for consideration of the longshore sediment transport and planform evolution.

Longshore Sediment Transport

The equations available for representing planform evolution are a sediment transport equation and a sand conservation (or continuity) equation. The transport equation is empirically based and describes the total transport in the longshore direction due to waves arriving at a breaking angle, α_b to the shoreline. The continuity equation is fundamental and simply balances sediment volume changes with transports into and out of the region under consideration. These equations are:

$$\text{Transport:} \qquad Q = \frac{K\, H_b^{5/2} \sqrt{g/\kappa}\, \sin(\beta - \alpha_b) \cos(\beta - \alpha_b)}{8(s-1)(1-p)} \tag{4}$$

$$\text{Continuity:} \qquad \frac{\partial \forall}{\partial t} = -\frac{\partial Q}{\partial x} \tag{5}$$

in which $\forall$ is sediment volume per unit length of beach, g is gravity, κ is the ratio of breaking wave height to water depth (usually taken as 0.78), β represents the azimuth of the outward normal to the shoreline, α_b represents the azimuth of the direction from which the breaking waves originate, s is the specific gravity of the sediment (approximately 2.65), p is the inplace porosity of the sediment (usually taken as 0.35) and t is time. Figure 13 presents a definition sketch for α_b and β. The sign convention used in this report is that the positive x (and Q) direction are to the right as an observer looks offshore.

For most shoreline evolution models and those that will be presented here, the model predicts the position of one contour, such as the NGVD contour or the SHWL contour.

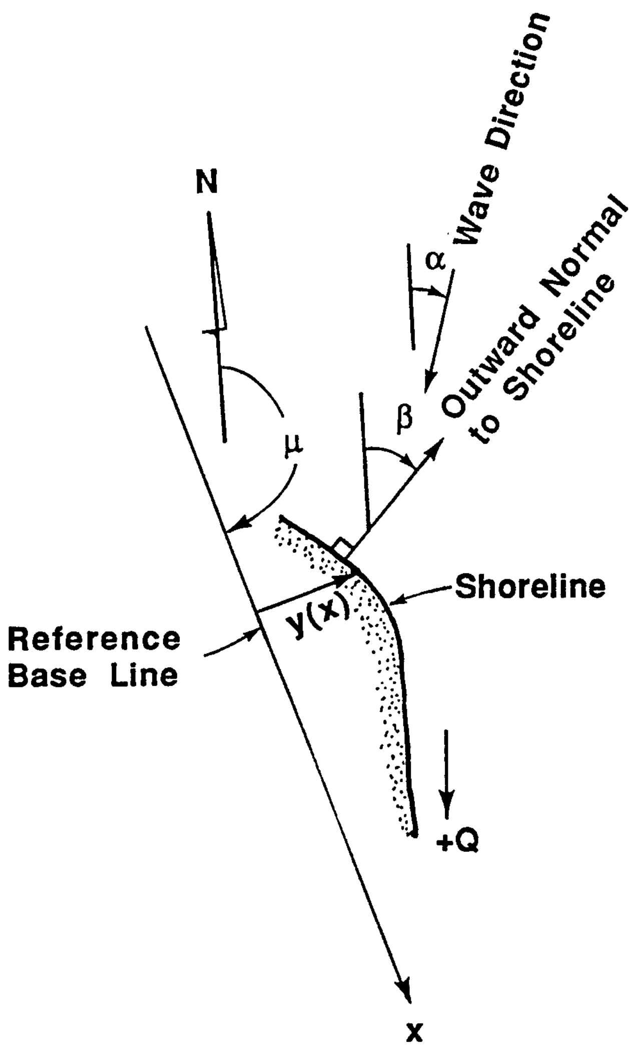


Figure 13. Definition Sketch.

These models assume that as beaches erode or accrete the profile moves without change of form in a landward or seaward direction, respectively. Thus after equilibration occurs, the shoreline change, Δy, associated with a volumetric change, $\Delta \forall$, can be shown to be given by

$$\Delta y = \frac{\Delta \forall}{(h_* + B)} \tag{6}$$

The two governing equations, namely the transport and conservation equations, can be applied directly to predict the evolution of a beach nourishment project or they can be combined in a linearized manner. Both of these approaches will be described in the following sections.

Combined Linearized Equations

Eq. (4) describes the sediment transport in terms of the difference between the shoreline orientation and wave direction. Foregoing the algebra, it can be shown that the combined and linearized equation governing the evolution of a beach system is

$$\frac{\partial y}{\partial t} = G \frac{\partial^2 y}{\partial x^2} \tag{7}$$

in which the parameter, G, can be interpreted as the "alongshore diffusivity" and is expressed as

$$G = \frac{K\, H_0^{2.4} C_{G_0}^{1.2} g^{0.4} \cos^{1.2}(\beta_0 - \alpha_0) \cos 2(\beta_0 - \alpha_*)}{8(s-1)(1-p) C_* \kappa^{0.4} (h_* + B) \cos(\beta_0 - \alpha_*)} \tag{8}$$

where the subscript "o" denotes deep water conditions, C_* is the wave celerity in the water depth h_* and Eq. (8) is derived in Appendix A. The ratio C_*/C_0 is

$$C_*/C_0 = \tanh\left(\frac{2\pi h_*}{L}\right) \tag{9}$$

in which $C_0 = gT/2\pi$, $C_{G_0} = gT/4\pi$ and C_*/C_0 is presented vs h_*/L_0 in Figure 14.

Figure 15 presents approximate values of G along the sandy beach shorelines of the state of Florida.

Equation (7) is the so-called heat conduction or diffusion equation which is well-known in classical physics and has many known solutions. Two solutions which are of interest

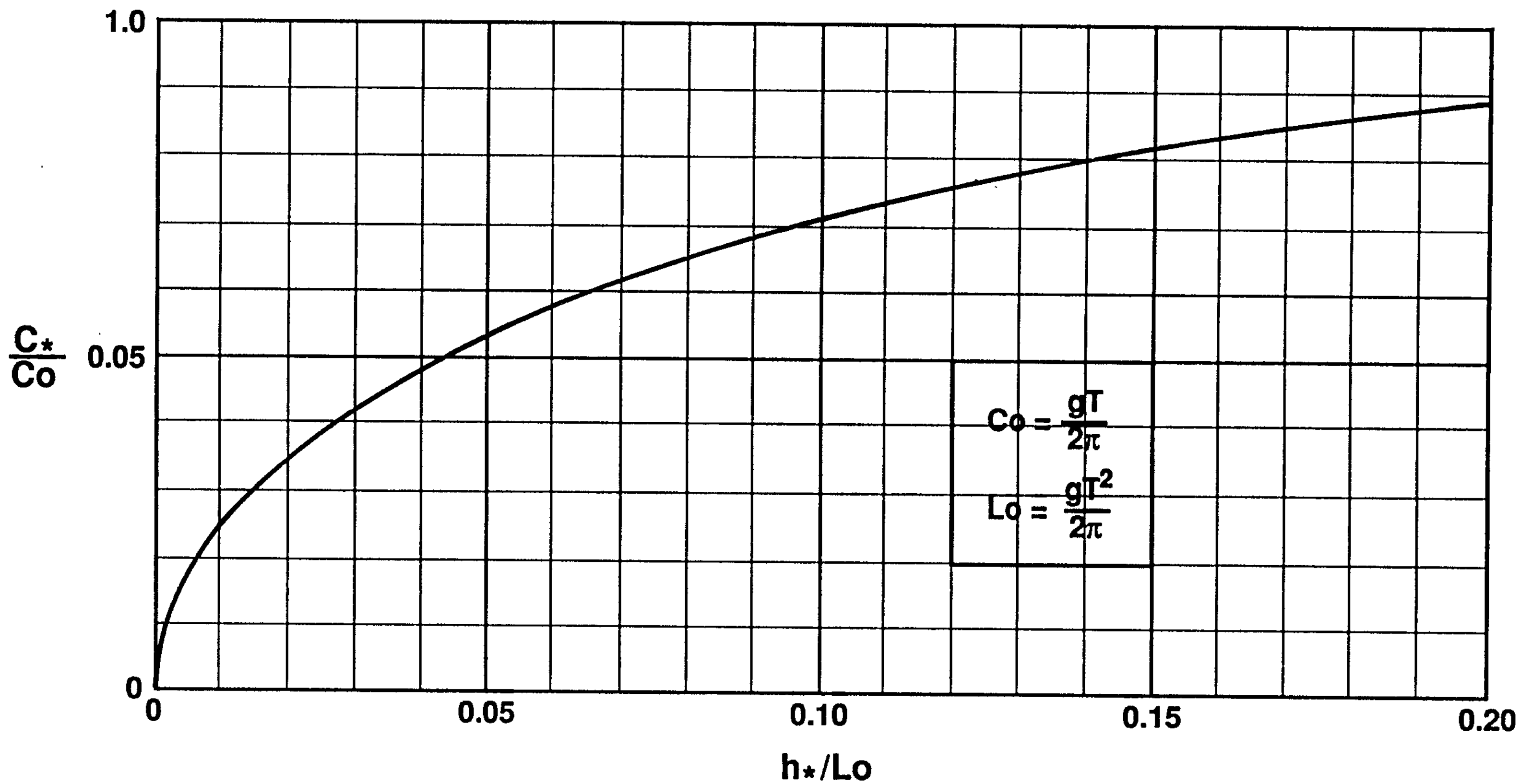


Figure 14. Variation of Ratio C*/Co vs. h*/Lo

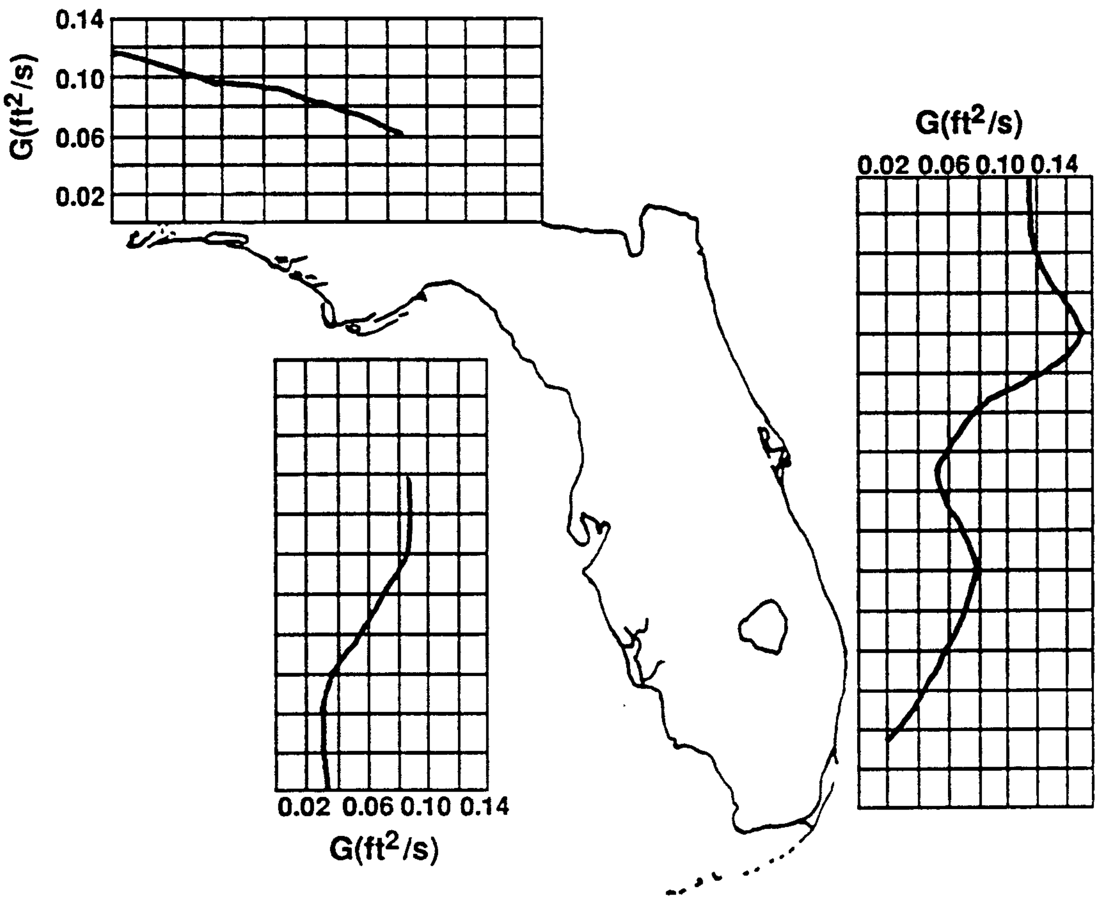


Figure 15. Approximate Estimates of G(ft^2/s) Around the Sandy Beach Shoreline of the State of Florida. Based on the Following Values: K = 0.77, g = 32.2 ft/sec^2, s = 2.65, p = 0.35, κ = 0.78, h_* From Fig. 8., B Estimates Ranging from 6 to 9 ft, H_o from Fig. 23, T from Fig. 24.

here will be discussed below; these solutions pertain to the graphical methodology thereby allowing a first estimate of the performance of a beach nourishment project. These solutions and the development of the combined and linearized equation concepts are due to Pelnard-Considere (1956).

Rectangular Beach Nourishment Project

The first solution of interest is for the evolution of an initially rectangular beach nourishment project of length, ℓ, which projects a distance Δy_0 from the original shoreline. The solution is

$$y(x,t) = \frac{\Delta y_0}{2}\left\{erf\left[\frac{\ell}{4\sqrt{Gt}}\left(\frac{2x}{\ell}+1\right)\right] - erf\left[\frac{\ell}{4\sqrt{Gt}}\left(\frac{2x}{\ell}-1\right)\right]\right\} \tag{10}$$

in which the term "erf" refers to the error function described mathematically as

$$erf(z) = \frac{2}{\sqrt{\pi}}\int_0^z e^{-u^2}du \tag{11}$$

in which u is a dummy variable.

Figure 16 illustrates an example of the performance of such a beach nourishment project and Figures 17a, b and c present the results in non-dimensional form. It can be seen from Eq. (9) that if the term $\frac{\ell}{\sqrt{Gt}}$ is the same for two beach nourishment projects the non-dimensional performance of the two beach nourishment projects will be the same. Thus, for two projects constructed with the same wave characteristics but with one project twice the length of the second project, the first project will lose the same percentage of sediment as the second project in a duration that is four times as long as that for the second project. Similarly if two projects have the same length but the first project has a wave height one-half that of the second wave height then the first project will have a longevity which is in excess of five times the longevity of the second project. In general this relationship may be stated as

$$t_2 = t_1\left(\frac{\ell_2}{\ell_1}\right)^2\left(\frac{H_1}{H_2}\right)^{2.4} \tag{12}$$

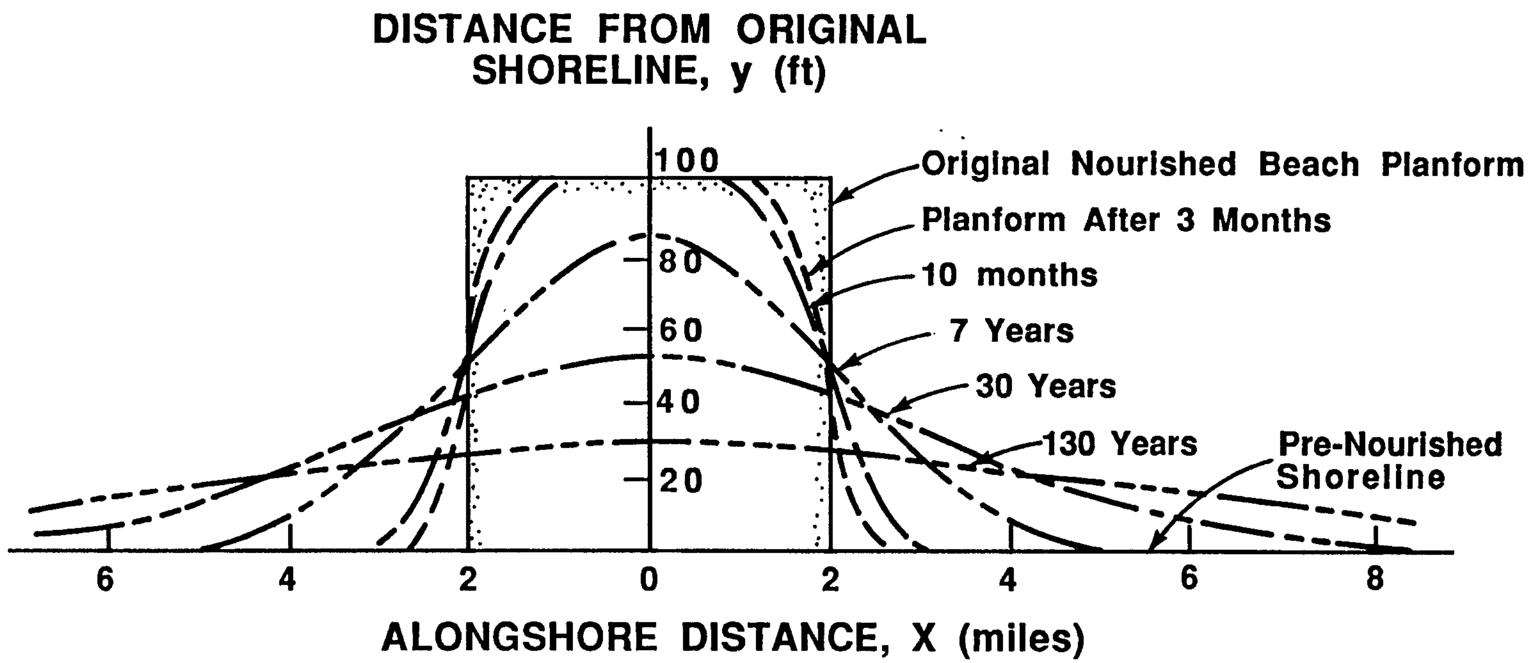


Figure 16. Example of Evolution of Initially rectangular Nourished Beach Planform. Example for Project Length, ℓ, of 4 Miles and Effective Wave Height, H, of 2 feet and Initial Nourished Beach Width of 100 Feet.

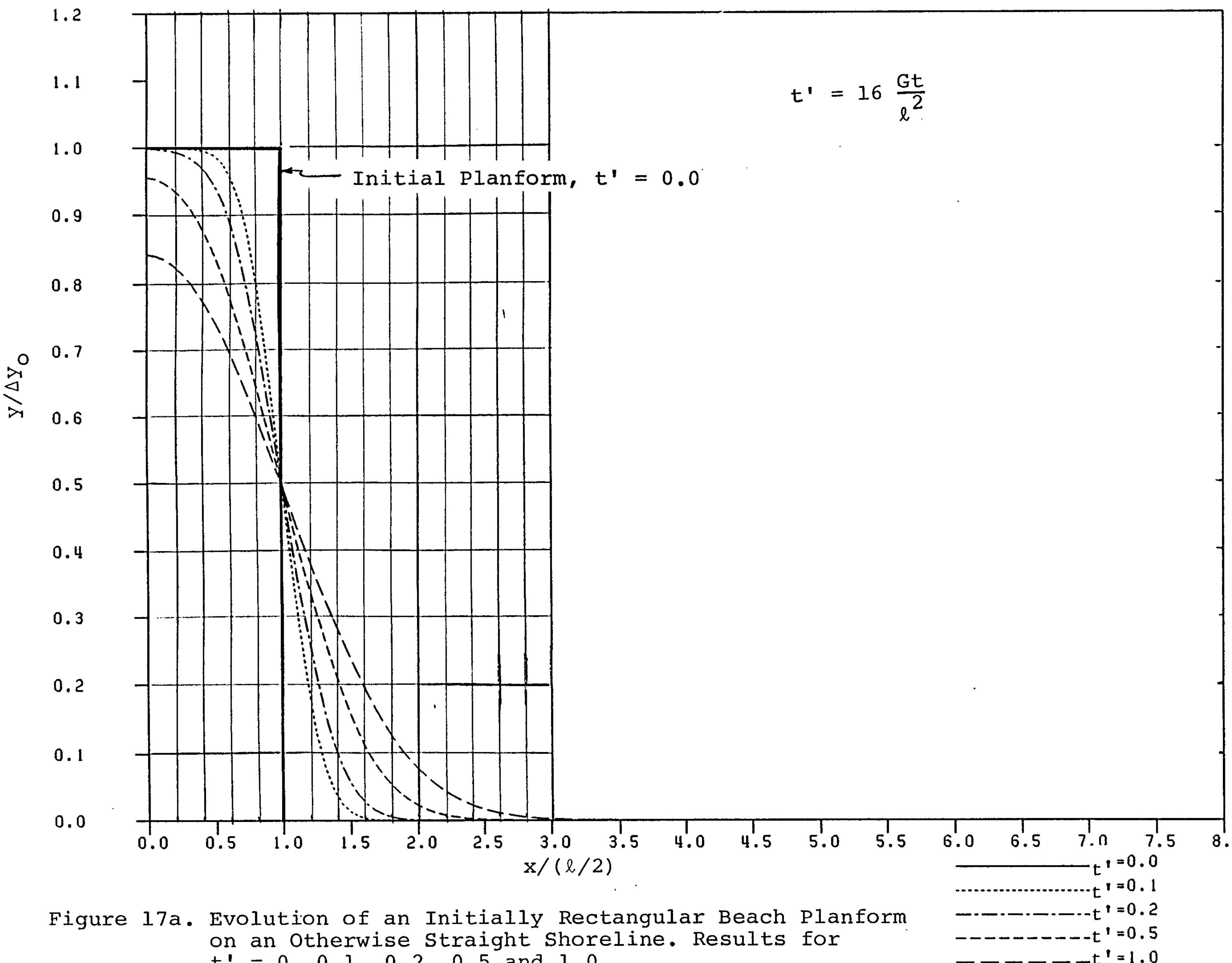
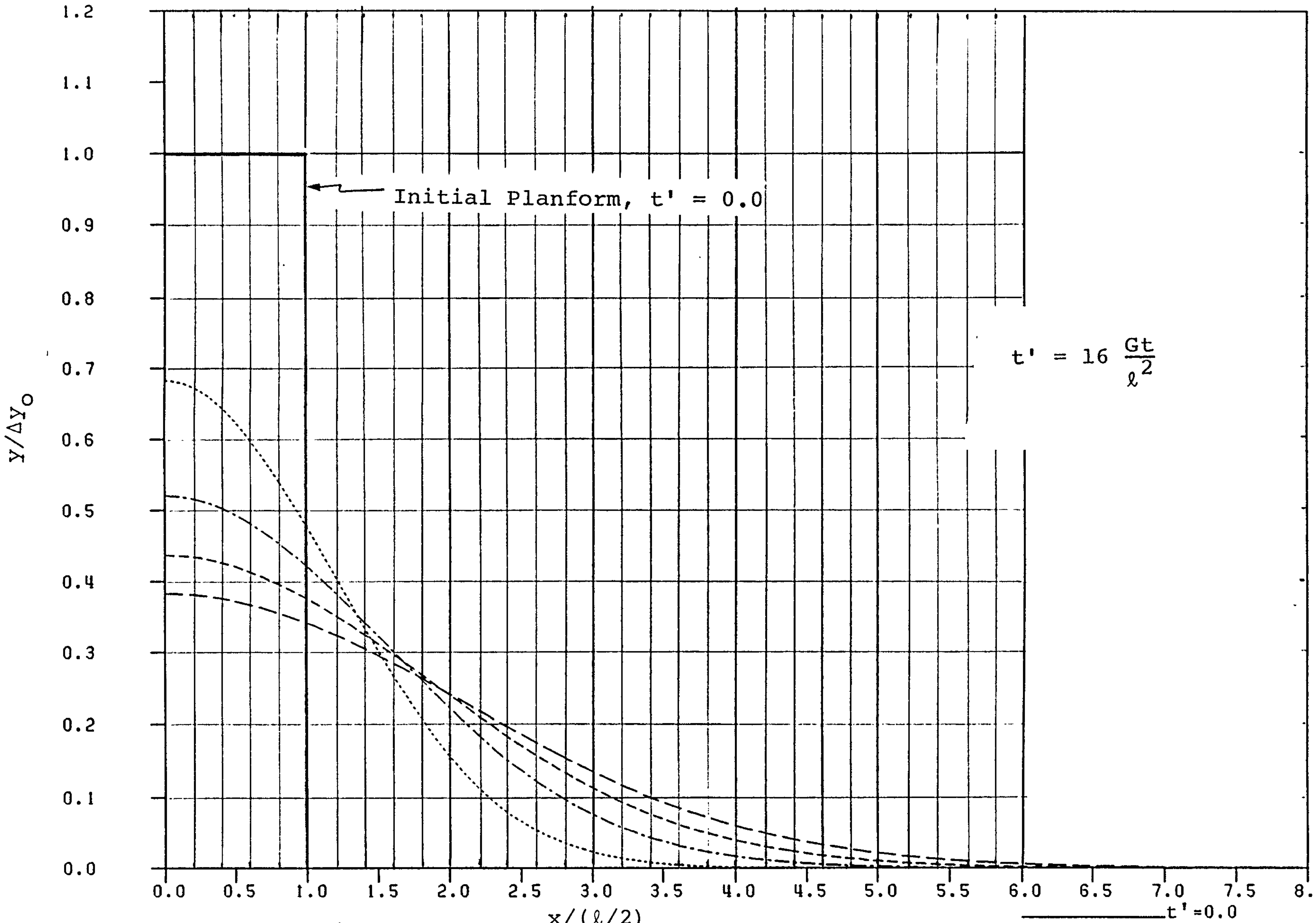


Figure 17a. Evolution of an Initially Rectangular Beach Planform on an Otherwise Straight Shoreline. Results for $t' = 0$, 0.1, 0.2, 0.5 and 1.0.



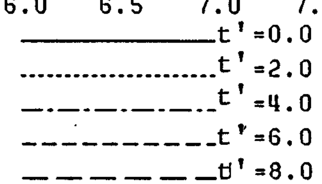


Figure 17b. Evolution of an Initially Rectangular Beach Planform on an Otherwise Straight Shoreline. Results for t' = 0,2.0,4.0, 6.0 and 8.0.

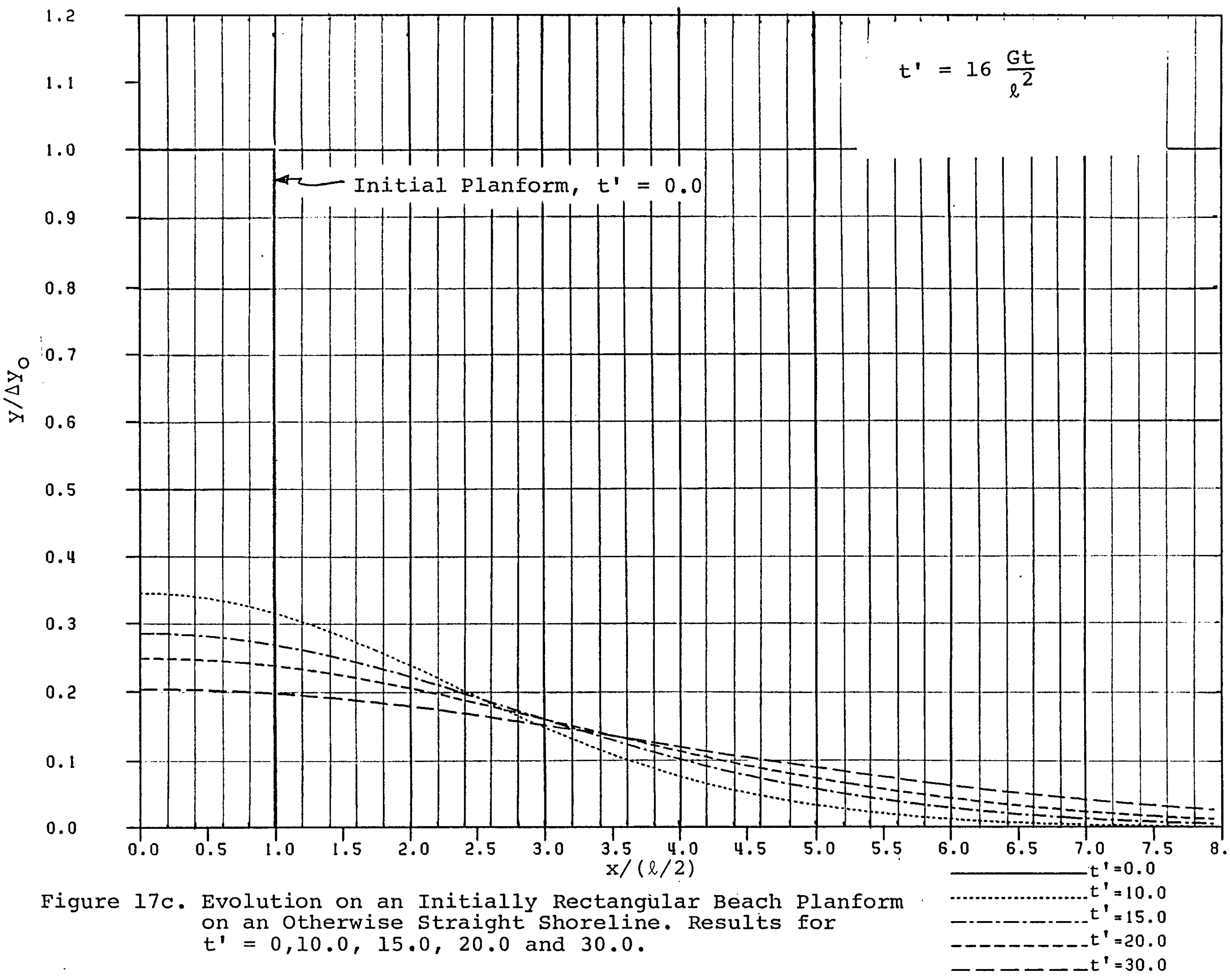


Figure 17c. Evolution on an Initially Rectangular Beach Planform on an Otherwise Straight Shoreline. Results for t' = 0,10.0, 15.0, 20.0 and 30.0.

in which t_1 and t_2 represent the times required for projects 1 and 2 to lose the same percentage of sand from the region placed. Thus, the longevity of a project in terms of the time required to lose a certain percentage of the sediment from the project area varies directly as the square of the length of the project and inversely as the 2.4 power of the wave height.

Equation (10) may be integrated to determine the fraction of material, M, remaining within the area placed. This is shown formally as

$$M(t) = \frac{1}{\Delta y_0 \ell} \int_{-\ell/2}^{\ell/2} y(x,t)dx \tag{13}$$

and upon carrying out the integration the result is

$$M(t) = \frac{2\sqrt{Gt}}{\ell\sqrt{\pi}} \left[e^{-(\ell/2\sqrt{Gt})^2} - 1 \right] + erf\left(\frac{\ell}{2\sqrt{Gt}}\right) \tag{14}$$

which is plotted in Figure 18 where the horizontal axis is the parameter encountered previously in the solution for the evolution of this particular planform.

If we are interested in the time required for 50% of the nourished material to be transported out of the area placed, then from Figure 17 we see that the appropriate value of $\sqrt{Gt}/\ell$ is 0.46. Thus the time required to lose 50% of the sediment from the region placed is

$$t_{50} = 0.21\frac{\ell^2}{G} \tag{15}$$

in which all variables are in consistent units. A more readily applied form is

$$t_{50} = 8.7\frac{\ell^2}{H_b^{5/2}} \tag{16}$$

where t_{50} is in years, ℓ is in miles and H_b is the breaking wave height in feet. As an example a project 2 miles in length with an effective breaking wave height of 2 ft would "lose" 50% of the volume placed due to spreading out losses in

$$t_{50} = 8.7\frac{2^2}{2^{2.5}} = 6.15 \text{ years} \tag{17}$$

It is emphasized that this solution is for a long unobstructed shoreline and includes only spreading out losses, i.e. no background erosion.

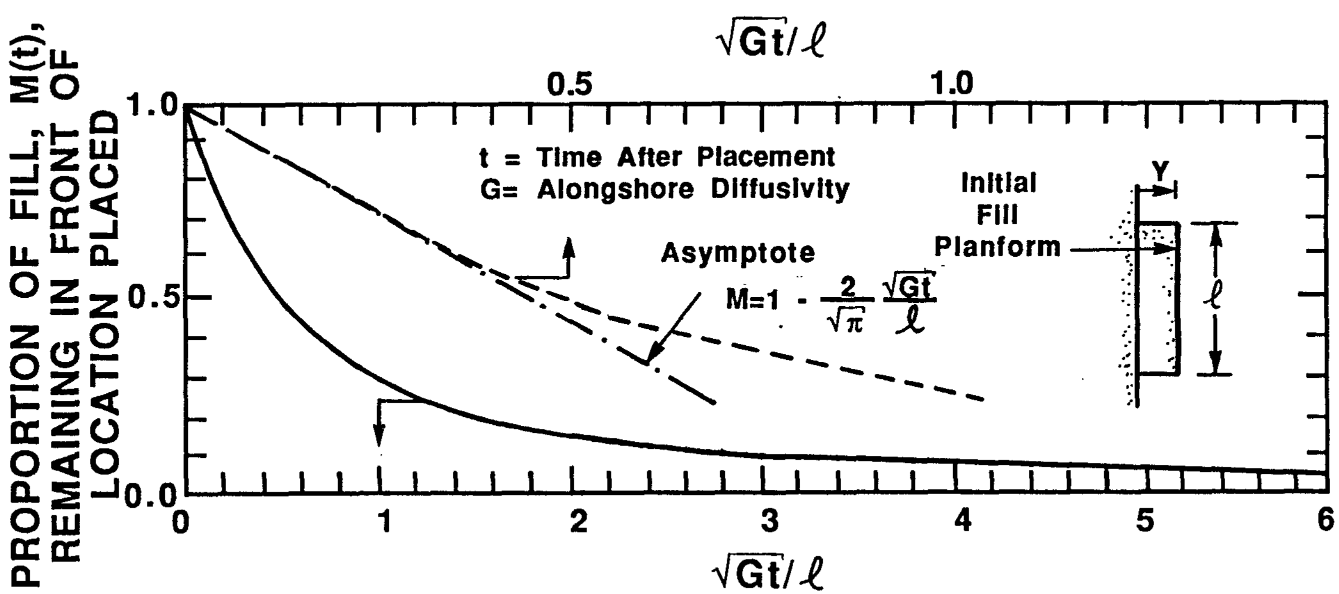


Figure 18. Percentage of Material Remaining in Region Placed vs. the Parameter $\sqrt{Gt/\ell}$.

Erosion Adjacent to a Littoral Barrier

The second analytical solution of relevance to this study is that of the downdrift erosion adjacent to a littoral barrier as shown in Figure 19. The solution for this situation is applicable for an initial condition of a straight and uniform shoreline and a wave arriving at a constant direction. The solution is presented as

$$y(x,t) = -\frac{\tan\theta}{\sqrt{\pi}}\left[\sqrt{4Gt}exp\left\{-\left(\frac{x^2}{4Gt}\right)\right\} - x\sqrt{\pi}erfc\left(\frac{x}{\sqrt{4Gt}}\right)\right], t < t_c \qquad (18)$$

$$y(x,t) = Yerfc\left(\frac{x}{\sqrt{4Gt}}\right) \quad , \quad t > t_c \qquad (19)$$

where

$$erfc(z) = 1 - erf(z) \qquad (20)$$

$$t_c = \frac{Y^2\pi}{4G\tan^2\theta} \qquad (21)$$

in which Y is the length of the structure, θ represents the angle of the approach wave and t_c is the time at which bypassing commences. Because we are interested primarily in the beach response downdrift of a barrier and there is usually no bypassing, Eq. (18) would be the solution of primary interest. Figure 20 presents the non- dimensional solution, $y/(\sqrt{4Gt}\tan\theta)$, versus non- dimensional distance, $x/\sqrt{4Gt}$, from the downdrift jetty.

There are two approaches to predicting shoreline changes downdrift of a littoral barrier, such as a jetty. One method, that just described, requires knowledge and specification of an effective wave direction. Available information to define wave directions is quite limited, especially on the west coast of Florida. Fortunately a second method, which will be recommended here, requires data which are more readily available along the Florida coastline.

The recommended procedure utilizes background erosion data rather than an effective wave direction. The justification for the use of background erosion data rather than wave

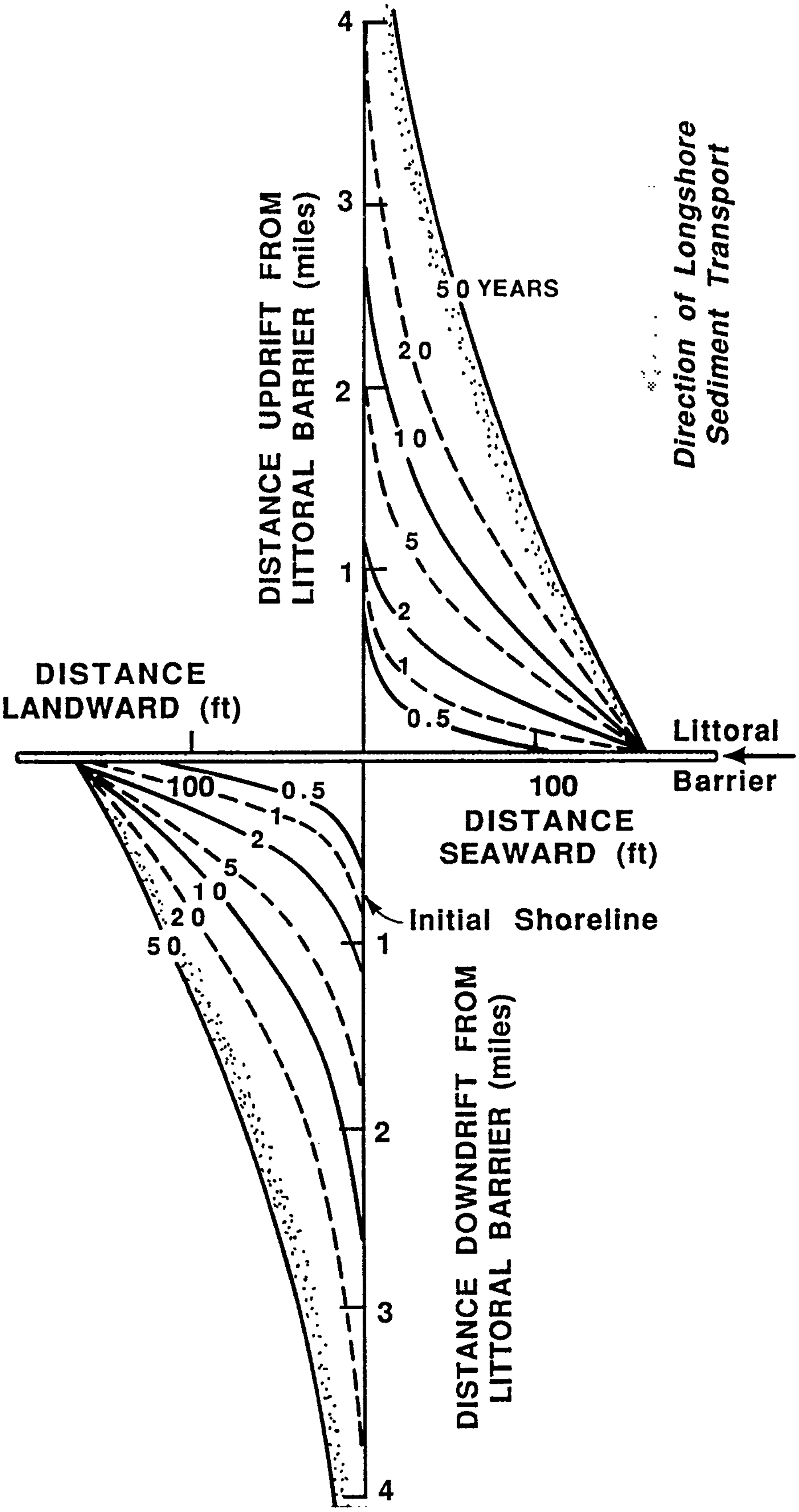


Figure 19. Example of Shoreline Evolution in Response to Littoral Barrier. Based on Method of Peinard-Considere. Longshore Sediment Transport Rate Used in Example =180,000 cubic yards per year. Littoral Barrier Length = 160 ft.

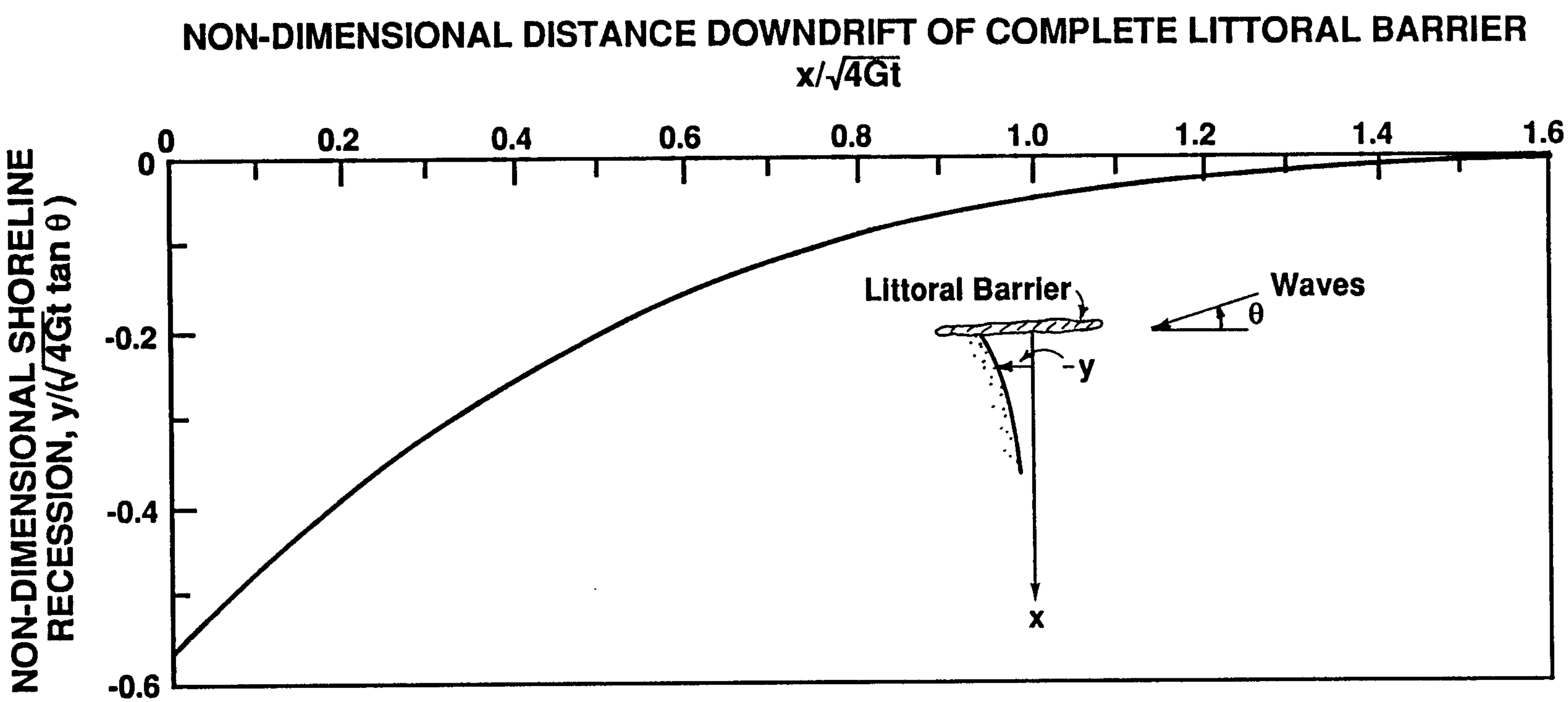


Figure 20. Pelnard - Considere Solution For Shoreline Recession Downdrift of a Complete Littoral Barrier.

direction is that the local background erosion rates in the vicinity of a littoral barrier are due to and a manifestation of waves arriving at the shoreline. This alternate recommended method would not be possible in the case where an inlet is to be cut because at that time there are no a priori background erosion data. Fortunately, in Florida, quite reliable background erosion data exist in the vicinity of most inlets.

For the recommended approach, the modifications to the graphical method described previously for an uninterrupted shoreline are small and are illustrated diagrammatically in Figure 21. The only changes are that (a) the effective length of the project, ℓ', is twice the physical length of the project, ℓ, and (b) the waves are considered as advancing normal to shore. This accomplishes the desired effect of a zero transport at the littoral barrier, since the transport at the center of a project for normally incident waves is zero.

The methods described here will be illustrated by later examples.

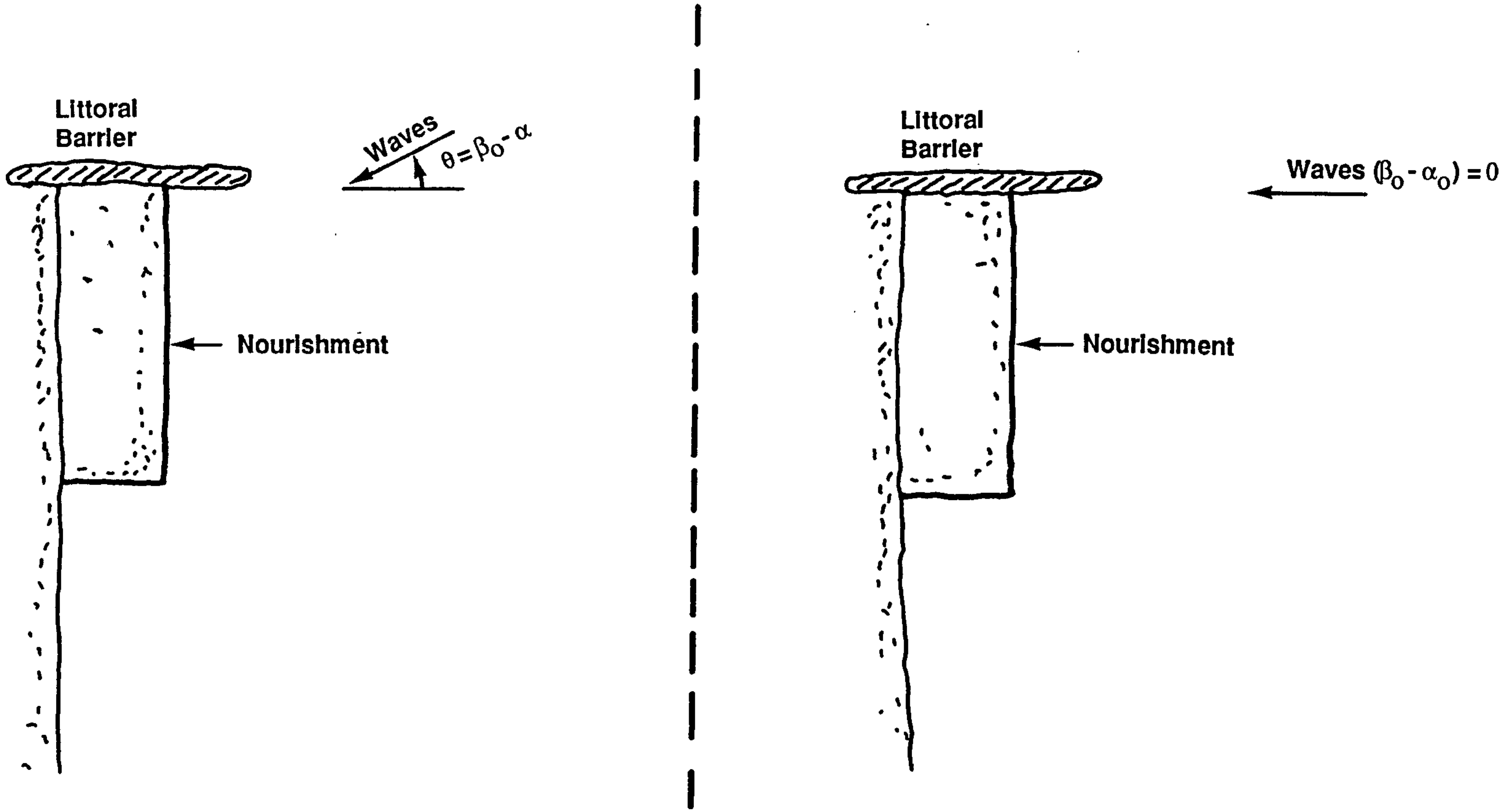
Numerical Solution

The numerical solution that will be presented here is a so- called explicit scheme in which the equations for sediment transport and continuity are solved sequentially. In particular referring to Figure 22, the shoreline positions are held constant for a time step, Δt, while the sediment transport is computed. Following this operation, the sediment transport is held constant for a time step and the equation of continuity is applied to these transport values to update the shoreline positions.

This type of explicit model referred to here has a stability criterion which limits the maximum time step, Δt, that can be utilized. The maximum time step is given approximately by

$$(\Delta t)_{max} = \frac{1}{2}\frac{\Delta x^2}{G} \tag{22}$$

and G is defined in Equation (8) and approximate values presented in Figure 15. For most purposes in Florida, a time step of 86,400 seconds (1 Day) and a grid size (Δx) of 500 feet are reasonable. From Eqs. (8) and (22) it is seen that the larger the wave height, the smaller the allowable time step. Also, the smaller the grid size, the smaller the allowable time step.



a) Method With Waves Approaching at a Specific Angle. Background Erosion Without Effect of Littoral Barrier

b) Recommended Method With Waves Approaching Normal to Shoreline. Background Erosion Includes Effect of Littoral Barrier.

Figure 21. Two Alternative Methods For Predicting Beach Nourishment Performance Downdrift of a Littoral Barrier

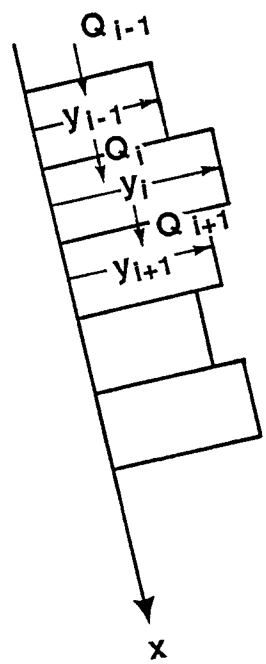


Figure 22. **Computational Scheme Used in Numerical Method.**

As noted previously, one of the primary advantages of the numerical solution is the much greater flexibility of specifying initial conditions and input to the model. Additionally, with minor modifications to the program, renourishments could be represented.

To effectively utilize the greater flexibility inherent in the numerical procedure and in particular to include structures where desired, the background erosion rates are translated into background transport rates. Formally the background transport rates, $Q_B(x)$, are determined from the continuity equation

$$Q_B(x) = Q_B(x_0) - (h_* + B) \int_{x_0}^{x} \frac{\partial y_B}{dt} dx \tag{23}$$

in which $\frac{\partial y_B}{dt}$ is the background shoreline change rate and x_0 is a reference shoreline location at which a reference transport $Q_B(x_0)$ is specified.

Boundary Conditions

The application of the sediment transport and continuity equations with initial planform conditions require specification of boundary conditions at the two ends of the grid system in order to complete the problem formulation. In general, there are two types of boundary conditions. The first that will be discussed is a specified shoreline position at one or both of the ends of the computational domain. A simple example of the specified shoreline positions would be that the shoreline is fixed at its initial value or the value could be prescribed over the computational time period. A second boundary condition that could be applied is a specified discharge at one or both ends of the computational domain. Examples of situations in which each of these boundary conditions would be applied are discussed below.

The fixed boundary condition could be applied at the ends of a computational domain for the case of a beach nourishment project on an uninterrupted shoreline; however, if the ends of the computational domain are too close to the changes that would occur due to the nourishment, then these conditions can adversely affect the accuracy of the results. A useful and direct approach to evaluating whether the fixed boundary conditions are sufficiently distant from the point of interest is to simply double the extent of the computational domain and to evaluate the effects on the shoreline changes in the region of interest over the period for which the computations are carried out.

The second type of boundary condition of interest is the specified transport boundary condition. Examples where a specified transport boundary condition would be appropriate are immediately downdrift of a partial or complete littoral barrier. If the barrier were a complete obstruction to the longshore sediment transport, then a specified discharge of zero would be appropriate; however, if there was some bypassing around the littoral barrier, then the volume per unit time of the bypassing would be the appropriate input transport boundary condition. Obviously in this case since the discharge values are centered at the grid lines, it would be appropriate to locate a grid line at the littoral barrier. The transport boundary condition could also be applied at the ends of the computational grid. If this were done, the shoreline displacement would be free to vary with time. If the transport boundary condition is specified as zero at the ends of the computational grid, there would be no change of volume within the computational domain. This could be the case in which complete littoral barriers existed at the two ends of the system of interest. In the model developed for this project, the boundary condition imposed at the two ends of the computational domain is the transport condition with the background transport as the imposed values.

A situation in which the boundary condition will change within the computational period might be a case where a groin of specified length was included somewhere within the computational domain. As the shoreline advances seaward toward the groin tip, the boundary condition would be a zero transport condition. However after the shoreline reached the end of the groin then the shoreline would remain fixed at that position which would in effect then be a fixed shoreline position boundary condition. In a case where the longshore sediment transport direction changed with time, the boundary condition at a structure could alternate between a fixed transport boundary condition and a specified shoreline position.

Wave and Other Parameters of Use in Applying the Methodology

Four parameters will be presented and recommended for applying the methodology developed in conjunction with this study.

The first parameter of interest is the limiting depth of motion, h_*. Although this quantity is not known precisely, recommended values for h_* have been presented in Figure 8. The berm height, B, is also required and appropriate values can be determined from profiles at the site of interest. Generally, berm heights range between 6 and 9 ft (above NGVD) in Florida.

A third parameter of interest is the effective wave height. The recommended distribution of wave heights around the Florida peninsula is shown in Figure 23. These wave heights were based primarily on the Coastal Data Network results where available. It is seen that, on the Florida east coast, the wave heights vary from the largest near the Florida/Georgia border and decrease toward the southern portions of the state. On the Florida west coast, the heights decrease toward the north with very low values along the Big Bend area, then increase toward the Florida/Alabama border. Finally, estimates of effective wave period are presented for the coast of Florida in Figure 24. Approximate values of the longshore diffusivity parameter, G, have been presented in Figure 15 and may be used as a reasonable approximation.

STEP-BY-STEP DISCUSSION OF METHODOLOGY

In this section the limitations and the step-by-step application of the graphical and numerical procedures will be presented.

Graphical Procedure

The graphical procedure as presented here pertains to (1) a rectangular nourishment on an uninterrupted shoreline, and (2) a rectangular beach nourishment immediately downdrift of a complete littoral barrier such as a jetty. In both of these cases it is considered that the shoreline change is the linear sum of the result of the spreading out losses and the background erosion rate as determined by historical data.

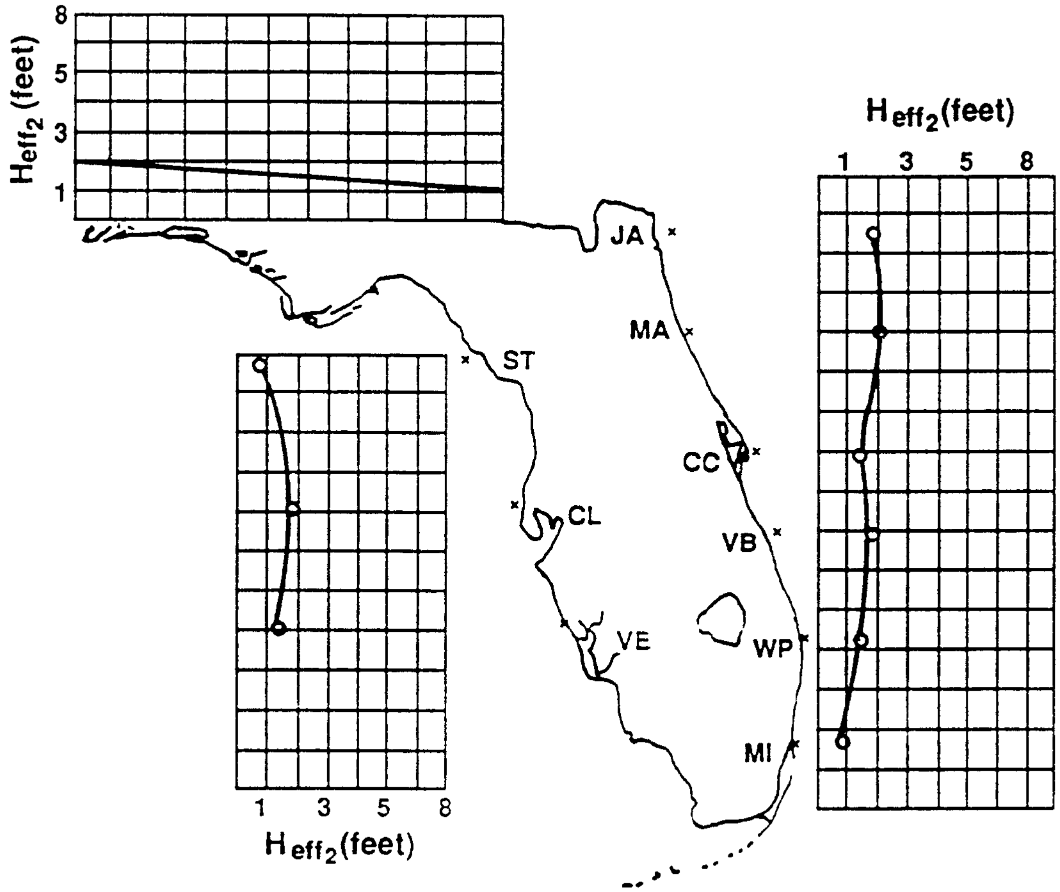


Figure 23. Recommended Values of Effective Deep Water Wave Height, H_0, Along Florida's Sandy Shoreline.

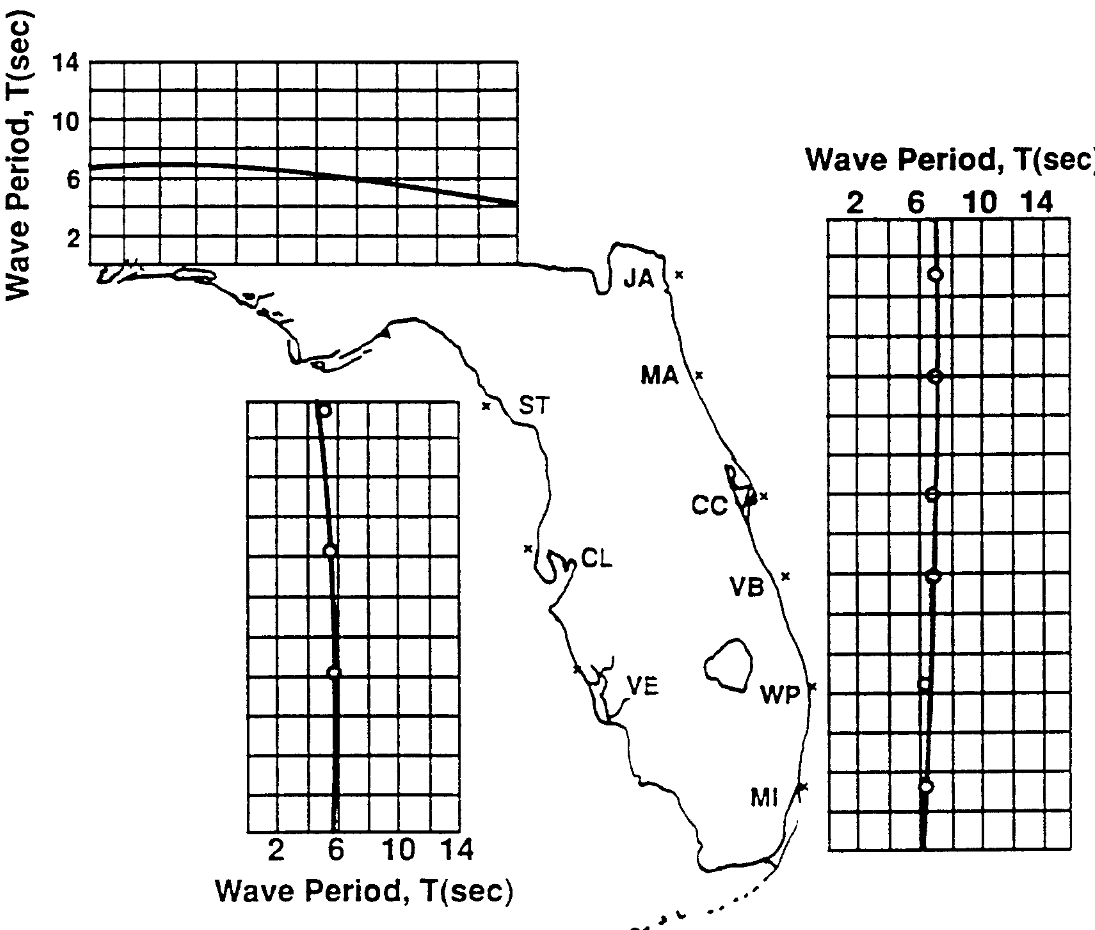


Figure 24. Recommended Values of Effective Wave Period, T, Along Florida's Sandy Shoreline.

CASE A - NOURISHMENT ALONG AN UNINTERRUPTED SHORELINE

The computation sheet presented as Figure 25 has been developed and should be referenced when reviewing the step-by-step procedure described below.

Step 1 - Specify Beach Nourishment Project Characteristics

These include

Project Length, ℓ

Sediment Size, D

Volume Added Per Unit Length, $V\!\!\!-$

Step 2 - Determine the Equilibrated Project Width, Δy_0

To accomplish this

- h_* from Figure 8
- Estimate B from local profile data berm height
- Determine A_F and A_N from Figure 7 from sediment sizes and local profile data, respectively
- Calculate $\Delta y_0/W_*$ from Figures 11 and 12, interpolating if necessary.

Step 3 - Calculate Effective Alongshore Diffusivity, G

The alongshore diffusivity, G, is obtained as expressed by Eq. (8) and is calculated from the wave, sediment and other local factors (G can also be estimated from Figure 15).

- Determine H_0 from Figure 23
- Determine T from Figure 24
- Determine C_* from Figure 14

BEACH NOURISHMENT PROJECTION
(Graphical Computations, Uninterrupted Shoreline)

General Location: ____________

Wave Height, H_0 (Fig. 23): ________ ft, Closure Depth, h_* (Fig. 8): _____ ft
Wave Period, T (Fig. 24): ________ sec, Sediment Size, D: ________ mm
Wave Direction, α_0: ____________ °, Transport Factor, K (Fig. 5): ________
Berm Height, B: _____ ft

Alongshore Diffusivity, G (From Equation below or Figure 15).

$$G = \frac{K}{8} \frac{H_0^{2.4} C_{G_0}^{1.2} g^{0.4} \cos(\beta_0 - \alpha_0) \cos 2(\beta_0 - \alpha_*)}{(s-1)(1-p) C_* \kappa^{0.4} (h_* + B) \cos(\beta_0 - \alpha_*)}$$

= ____________________ = ____________ ft^2/s

Background Erosion

x	Erosion Rate (ER) ft/yr
___	________
___	________
___	________
___	________
___	________
___	________
___	________
___	________
___	________
___	________

Equilibrated Beach Width, Δy_0

A_N (Fig. 7) or From Profile: ________ $ft^{1/3}$
A_F (Fig. 7): ________ $ft^{1/3}$
Volume Per Unit Length: ________ ft^3/ft
Δy_0 (Figs. 11 and 12): ________ ft
Project Length, ℓ, = _____ miles = ________ ft

For 30 years

$$16\frac{Gt}{\ell^2} = 16\frac{G(30x365x24x3600)}{\ell^2} = \qquad =$$

(1)	(2)	(3)	(4)	(5)	(6)
Distance From Center, x(ft)	$\frac{x}{\ell/2}$	$y\left(\frac{x}{\ell/2}\right)/\Delta y_0$ (Fig. 17)	y_s (ft)	y_B(ft) = 30 x ER	$y_N =$ $y_s - y_b$ (ft)
___	___	___	___	___	___
___	___	___	___	___	___
___	___	___	___	___	___
___	___	___	___	___	___
___	___	___	___	___	___
___	___	___	___	___	___
___	___	___	___	___	___

Figure 25. Form for Computation of Performance Along Uninterrupted Shoreline.

- Other Recommended Values:

$$\kappa = 0.78$$

$$s = 2.65$$

$$p = 0.35$$

$$g = 32.2$$

Step 4 - Calculate Shoreline Position Due to Spreading Out Losses

- Calculate non-dimensional time for $t = 30$ years or other time of interest

$$t' = 16\frac{Gt}{\ell^2}$$

where all variables are in consistent units

- Calculate $x/(\ell/2)$ at locations of interest (Column 2, Bottom Table in Figure 25)
- Determine $y/\Delta y_0$ from Figure 17 (Column 3, Bottom Table in Figure 25)

Step 5 - Calculate Background Erosion Losses

- Estimate background erosion rate from DNR data base
- Multiply rate by time (30 years) to obtain background erosion component (Column 5, Bottom Table in Figure 25)

Step 6 - Calculate Resulting Shoreline Position

Add linearly the changes due to spreading out losses and background erosion to obtain the total changes. If the area of interest is not within the project area, apply the same methodology, however, here the spreading out losses (from the project area) will result in a shoreline advancement (see Figure 3).

CASE B - NOURISHMENT DOWNDRIFT OF A LITTORAL BARRIER

As discussed previously, there are two methods for calculating response downdrift of a littoral barrier. It is recommended that the method utilizing background erosion data be applied rather than the method requiring the wave approach angle. The recommended method is described below.

The computation sheet presented as Figure 26 for this case has been developed and should be referenced along with the step-by-step procedure described.

Step 1 - Specify Beach Nourishment Characteristics

These include (same as for Case A)

Project Length, ℓ (Effective Length, $\ell' = 2\ell$)

Sediment Size, D

Volume Added Per Unit Length, $\forall$

Step 2 - Determine the Equilibrated Project Width, Δy_0

(Same procedure as for Case A)

- h_* from Figure 8
- Estimate B from local profile data berm height
- Determine A_F and A_N from Figure 7 and local profile data, respectively
- Calculate $\Delta y_0/W_*$ from Figures 11 and 12, interpolating if necessary.

Step 3 - Calculate Effective Alongshore Diffusivity, G

(Same as for Case A)

The alongshore diffusivity, G, is obtained as expressed by Eq. (8) and is calculated from the wave, sediment and other local factors (G can also be estimated from Figure 15).

- Determine H_0 from Figure 23
- Determine T from Figure 24
- Determine C_* from Figure 14

BEACH NOURISHMENT PROJECTION
(Graphical Computations, Downdrift of a Littoral Barrier)

General Location: ____________

Wave Height, H_0 (Fig. 23): ________ ft, Closure Depth, h_* (Fig. 8): _____ ft
Wave Period, T (Fig. 24): ________ sec, Sediment Size, D: ________ mm
Wave Direction, α_0: ____________°, Transport Factor, K (Fig. 5): ________
Berm Height, B: _____ ft

Alongshore Diffusivity, G(From Equation Below or Figure 15)

$$G = \frac{K}{8} \frac{H_0^{2.4} C_{G_0}^{1.2} g^{0.4} \cos(\beta_0 - \alpha_0) \cos 2(\beta_0 - \alpha_*)}{(s-1)(1-p) C_* \kappa^{0.4} (h_* + B) \cos(\beta_0 - \alpha_*)}$$

$$= \underline{\hspace{6cm}} = \underline{\hspace{4cm}} \text{ft}^2/s$$

Background Erosion

x	Erosion Rate	(ER) ft/yr
___	________	
___	________	
___	________	
___	________	
___	________	
___	________	
___	________	
___	________	
___	________	
___	________	

Equilibrated Beach Width, Δy_0

A_N (Fig. 7) or From Profile: ________ $\text{ft}^{1/3}$
A_F (Fig. 7): ________ $\text{ft}^{1/3}$
Volume Per Unit Length: ________ ft^3/ft
Δy_0 (Figs. 11 and 12): ________ ft
Project Length, ℓ, = _____ miles = ________ ft
Effective Project Length, $\ell' = 2\ell$ = _____ miles = ________ ft

For 30 years

$$16\frac{Gt}{(\ell')^2} = 16\frac{G(30\text{x}365\text{x}24\text{x}3600)}{(\ell')^2} = \qquad =$$

(1)	(2)	(3)	(4)	(5)	(6)
Distance From Littoral Barrier, x(ft)	$\frac{x}{\ell'/2}$	$y\left(\frac{x}{\ell'/2}\right)/\Delta y_0$ (Fig. 17)	y_s (ft)	y_B(ft) = 30 x ER	$y_N = y_s - y_b$ (ft)
___	___	___	___	___	___
___	___	___	___	___	___
___	___	___	___	___	___
___	___	___	___	___	___
___	___	___	___	___	___
___	___	___	___	___	___
___	___	___	___	___	___

Figure 26. Form for Computation of Performance Downdrift of a Littoral Barrier.

- Other Recommended Values:

$$\kappa = 0.78$$
$$s = 2.65$$
$$p = 0.35$$
$$g = 32.2$$

Step 4 - Calculate Shoreline Position Due to Spreading Out Losses

- Calculate non-dimensional time for $t = 30$ years or other time of interest

$$t' = \frac{16\,Gt}{(\ell')^2} = \frac{4\,Gt}{\ell^2}$$

where all variables are in consistent units.

(Note: Different coefficient from Case A)

- Calculate $x/(\ell'/2)$ at locations of interest where the origin of x is at the littoral barrier

- Calculate $y/\Delta y_0$ from Figure 17 (Note in this case, the horizontal axis in Figure 17 is to be interpreted as $x/(\ell'/2)$ or equivalently, x/ℓ.)

Step 5 - Calculate Background Erosion Losses

- Estimate background erosion rate from DNR data base

- Multiply rate by time to obtain background erosion component

Step 6 - Calculate Resulting Shoreline Position

Add linearly the changes due to spreading out losses and background erosion to obtain the total changes. If the area of interest is not within the project area, apply the same methodology, however, here the spreading out losses (from the project area) will result in a shoreline advancement (see Figure 3).

NUMERICAL PROCEDURE

As noted previously, the numerical procedure provides greater flexibility for representing shoreline and beach nourishment conditions. Prior to using the program, there is a certain amount of data preparation that is required. Some of this preparation is similar to that for the graphical procedure as described earlier. The numerical procedure also allows input of structures of arbitrary lengths at any location within the computational domain. At this stage, the program is straightforward, but not overly "user friendly".

As for the case of the "Graphical Procedure", the methodology will be illustrated below for the case of nourishment along an uninterrupted shoreline and for the case of structures present. The preparation sheet presented as Figure 27 has been developed to assist in data preparation and should be referenced along with the step-by-step procedure described below.

CASE A - NOURISHMENT ALONG AN UNINTERRUPTED SHORELINE

STEP 1 - Specify Beach Nourishment Project Characteristics

This is the same as described previously for the Graphical Procedure. The only difference is that now greater flexibility is available with the numerical procedure allowing varying volumes of nourishment along the shoreline including any number of nourishment segments.

STEP 2 - Determine Equilibration Project Width, Δy_0

Utilize same method as described for Graphical Procedure

STEP 3 - Develop Background Erosion Data as Piecewise Linear Segments

STEP 4 - Develop Input File

A description of the input file (DNRBS.INP) is given below and Figure 28 presents an example input file.

BEACH NOURISHMENT PROJECTION
(Numerical Procedure)

General Location: ________________

Wave Height, H_0 (Fig. 23):	______ ft.,	Closure Depth, h_* (Fig. 8):	______ ft.
Wave Period, T (Fig. 24):	______ sec.,	Berm Height, B:	______ ft.
Wave Direction, α_0:	______ °,	Sand Diameter, D:	______ mm
Deep Water Contour Orientation, β_0:	______ °,	Transport Factor, K (Fig. 5):	______
Longshore Axis Orientation, μ:	______ °,	VFACT:	______
Grid Dimension, Δx:	______ ft	Background Transport, QREF:	______ ft^3/s
Time Increment, Δt:	______ sec	IREF:	______
		IMAX:	______
		NTIMES:	______
		No. of Structures, NS:	______

Structure Specificiation			Background Erosion	
Structure Number	Structure Location, I	Structure Length (ft)	x	Erosion Rate, ER, (ft/yr)
1	______	______	______	______
2	______	______	______	______
3	______	______	______	______
4	______	______	______	______
5	______	______	______	______
6	______	______	______	______

Equilibrated Beach Width Δy_0		Nourishment Specification	
		I Range	Δy_0
A_N (Fig. 7) or From Profile:	______ $ft^{1/3}$	______ to ______	______
A_F (Fig. 7):	______ $ft^{1/3}$	______ to ______	______
Volume Per Unit Length:	______ ft^3/ft	______ to ______	______
Δy_0 (Figs. 11 and 12):	______ ft	______ to ______	______
		______ to ______	______

Figure 27. Data Input Preparation Form for Numerical Procedure.

EXAMPLE OF INPUT FILE: DNRBS.INP
(Example No. 2)

```
EXAMPLE NO. 2 UNIF. BACK. EROS. NO STRUC. 2 MILE PROJ.
2.00      6.0      90.0      90.0     180.0     500.0 86400.0
17.0      6.0      0.77      1.0       0.0      1     180 10950     0
 0.0      2.0  90000.       2.0  49500.        2.0   60000.        3.0
90000.    3.0 100000.       3.0 140000.        2.0
80    100
80    112.0
81    112.0
82    112.0
83    112.0
84    112.0
85    112.0
86    112.0
87    112.0
88    112.0
89    112.0
90    112.0
91    112.0
92    112.0
93    112.0
94    112.0
95    112.0
96    112.0
97    112.0
98    112.0
99    112.0
100   112.0
```

- Line 1: Identification Card
- Line 2: Wave Height, H_o; Wave Period, T; Deep Water Wave Direction, α_o; Deep Water Coordinate Orientation, β_o; Axis Orientation, μ; Grid Size, Δx; Time Increment, Δt
- Line 3: h_*, Depth of Active Motion; B, Berm Height; K; Nourishment Factor, VFACT; QBKREF; IREF; No. of Grids, IMAX; No. of Time Steps, NTIMES; No. of Structures, NS
- Lines 4–5: Pairs of (Distances, Erosion Rates)
- Line 6: First Grid Cell Nourished, NNOUS; Last Grid Cell Nourished, NNOUE
- Remaining lines: Pairs of Grid Cell No., Δy_o Values

Note: The Blank Lines Between Cards Were Provided Here For Annotation Purposes

Figure 28. Input File DNRBS.INP For Example 2

Card 1 (Format: 20A4): Identification Card with 80 Characters of Alphanumeric Input

Card 2 Format: 8F8.2): Contains the Following Input Parameters
First Parameter: Deep Water Effective Wave Height in Feet, H_0 (From Figure 23)
Second Parameter: Wave Period in Seconds, T (From Figure 24)
Third Parameter: Deep Water Wave Direction, α_0, in Degrees
Fourth Parameter: Deep Water Contour Orientation, β_0, in Degrees
Fifth Parameter: Longshore Axis Orientation, μ, in Degrees
Sixth Parameter: Grid Dimension, Δx, in Feet
Seventh Parameter: Time Increment, Δt, in Seconds

Card 3 Format: 5F8.2,4I6): Contains the Following Input Parameters
First Parameter: Depth of Limiting Motion, h_*, in Feet (From Figure 8)
Second Parameter: Berm Height, B, in Feet
Third Parameter: Sediment Transport Parameter, K (From Figure 5)
Fourth Parameter: Factor to Increase or Decrease Proportionally All Input Beach Widths, Δy_0
Fifth Parameter: Background Transport, QBKREF (cubic feet/sec) (See Eq. (23))
Sixth Parameter: Grid Line Index, IREF, at Which QBKREF is to Apply
Seventh Parameter: Number of Grids, IMAX
Eighth Parameter: Number of Time Steps, NTIMES
Ninth Parameter: Number of Structures, NS

Card 4 Format: 5(I6,F8.3)): Note this Card (and Possibly a Subsequent Card if NS > 5) is only Present if NS > 0 and Contains NS Pairs of Grid Lines and Structure Lengths. At Present the Program is Dimensioned to Accommodate Up To 10 Structures

Cards 5 and 6 Format (8F8.2): These Two Cards Contain Pairs of $(x, EB(x))$ where x is in Feet and EB is the Location Background Erosion in Feet/Year. The Program is Presently Configured for Seven Pairs; However, it is Possible to Specify Background Erosion Conditions with as Little as Two Pairs. For Example, if the Background Erosion is Uniform at Two Feet/Year and the Computational Domain is 60,000 ft in Length, the Two Active Pairs Could be: 0.0 2.0 80000.0 2.0
The Remaining Five Pairs Entered Would be Immaterial. Note it is necessary to provide two cards here, even if all the meaningful information is contained in the first card.

Card 7 This Card Specified the First, NNOUS, and Last, NNOUE, Grid Indices for the Nourished Segment

Cards 8 and Following (Format: I6, 3F8.2): Each of These Cards Specifies the Grid Index, I, and the Associated Shoreline Advancement, Δy_0 (I)

This completes specification of the input File DNRBS.INP

STEP 5 - Run Program

STEP 6 - Examine Output in File DNRBS.OUT

A description of the output file DNRBS.OUT is presented below and Figure 29 presents an example of this output with annotations. This output is for the input file presented in Figure 28.

Card 1: This card is an image of the first input card which is an identification card

Cards 2,3,4,5,6: These cards simply repeat input values

Cards 7 and 8: These two cards are pairs of $(x, EB(x))$ specified in Input Cards 5 and 6

Next Block of Data: Presents pairs of (I, Q_{BI}) in which Q_{BI} is the background erosion transport across the I^{th} grid line. The units of Q_{BI} are in ft^3/sec

Next Card: This card repeats the first nourished grid index, NNOUS, and the last nourishment grid index, NNOUE, as provided by Input Card 7

Next Block of Data: Presents three entries per grid: * (I,X(I), DYO(I)), in which I is the grid block index, x(I) is the x coordinate of the grid block and DYO(I) is the initial nourished width at the grid block. In the example presented, because there are 450 sets of entries, one for each grid block.

Next Block of Data: Provides pairs of I, Y(I) for one year after nourishment for all grid blocks

Next Card: Presents the proportion of the additional dry beach area relative to the initial area that remains within the project area after one year. This proportion is denoted PCT(LCUR)

Remaining Output: The remaining output consists of detailed shoreline output for 5, 10, 20 and 30 years and the proportional surface area remaining for each of the thirty years.

This completes the description of the information in the output file DNRBS.OUT

Figure 29. Example of Output File DNRBS.OUT for Input File in Figure 28. Example No. 2. (Total of 5 Pages of Output).

```
                    EXAMPLE OF OUTPUT FILE: DNRBS.OUT
                            (Example No. 2)

   EXAMPLE NO. 2 UNIF. BACK. EROS. NO STRUC. 2 MILE PROJ.

 HO =   2.00 FT., T =   6.00 SEC.,  ALPO =  90.00 DEG., BTAO =  90.00 DEG.,
XMU =  180.00 DEG., DX =   500.00 FT., DT = 86400.00 SEC.
 HSTR =     17.00 FT., B =      6.00 FT., XK =       .77 VFACT =      1.00
    QBKREF =       .00 FT.**3/SEC.
   IREF =       1, IMAX =    180, NTIMES =    10950, NS =      0



 .00E+00    2.00 .90E+05    2.00 .50E+05    2.00 .60E+05    3.00
 .90E+05    3.00 .10E+06    3.00 .14E+06    2.00
```

BACKGROUND EROSION TRANSPORT RATES

1	.000	2	.001	3	.001	4	.002	5	.003
6	.004	7	.004	8	.005	9	.006	10	.007
11	.007	12	.008	13	.009	14	.009	15	.010
16	.011	17	.012	18	.012	19	.013	20	.014
21	.015	22	.015	23	.016	24	.017	25	.018
26	.018	27	.019	28	.020	29	.020	30	.021
31	.022	32	.023	33	.023	34	.024	35	.025
36	.026	37	.026	38	.027	39	.028	40	.028
41	.029	42	.030	43	.031	44	.031	45	.032
46	.033	47	.034	48	.034	49	.035	50	.036
51	.036	52	.037	53	.038	54	.039	55	.039
56	.040	57	.041	58	.042	59	.042	60	.043
61	.044	62	.044	63	.045	64	.046	65	.047
66	.047	67	.048	68	.049	69	.050	70	.050
71	.051	72	.052	73	.053	74	.053	75	.054
76	.055	77	.055	78	.056	79	.057	80	.058
81	.058	82	.059	83	.060	84	.061	85	.061
86	.062	87	.063	88	.063	89	.064	90	.065
91	.066	92	.066	93	.067	94	.068	95	.069
96	.069	97	.070	98	.071	99	.071	100	.072
101	.073	102	.074	103	.074	104	.075	105	.076
106	.077	107	.077	108	.078	109	.079	110	.079
111	.080	112	.081	113	.082	114	.082	115	.083
116	.084	117	.085	118	.085	119	.086	120	.087
121	.088	122	.088	123	.089	124	.090	125	.090
126	.091	127	.092	128	[illegible]	129	.093	130	.094
131	.095	132	.096	133		134	.097	135	.098
136	.098	137	.099	138		139	.101	140	.101
141	.102	142	.103	143	.104	144	.104	145	.105
146	.106	147	.106	148	.107	149	.108	150	.109

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156	.113	157	.114	158	.115	159	.115	160	.116
161	.117	162	.117	163	.118	164	.119	165	.120
166	.120	167	.121	168	.122	169	.123	170	.123
171	.124	172	.125	173	.125	174	.126	175	.127
176	.128	177	.128	178	.129	179	.130	180	.131
181	.131								

80 100

INITIAL SHORELINE (INCL. NOURISHMENT) POSITION

1	0.	.00	2	500.	.00
3	1000.	.00	4	1500.	.00
5	2000.	.00	6	2500.	.00
7	3000.	.00	8	3500.	.00
9	4000.	.00	10	4500.	.00
11	5000.	.00	12	5500.	.00
13	6000.	.00	14	6500.	.00
15	7000.	.00	16	7500.	.00
17	8000.	.00	18	8500.	.00
19	9000.	.00	20	9500.	.00
21	10000.	.00	22	10500.	.00
23	11000.	.00	24	11500.	.00
25	12000.	.00	26	12500.	.00
27	13000.	.00	28	13500.	.00
29	14000.	.00	30	14500.	.00
31	15000.	.00	32	15500.	.00
33	16000.	.00	34	16500.	.00
35	17000.	.00	36	17500.	.00
37	18000.	.00	38	18500.	.00
39	19000.	.00	40	19500.	.00
41	20000.	.00	42	20500.	.00
43	21000.	.00	44	21500.	.00
45	22000.	.00	46	22500.	.00
47	23000.	.00	48	23500.	.00
49	24000.	.00	50	24500.	.00
51	25000.	.00	52	25500.	.00
53	26000.	.00	54	26500.	.00
55	27000.	.00	56	27500.	.00
57	28000.	.00	58	28500.	.00
59	29000.	.00	60	29500.	.00
61	30000.	.00	62	30500.	.00
63	31000.	.00	64	31500.	.00
65	32000.	.00	66	32500.	.00
67	33000.	.00	68	33500.	.00
69	34000.	.00	70	34500.	.00
71	35000.	.00	72	35500.	.00
73	36000.	.00	74	36500.	.00
75	37000.	.00	76	37500.	.00
77	38000.	.00	78	38500.	.00
79	39000.	.00	80	39500.	112.00
81	40000.	112.00	82	40500.	112.00
83	41000.	112.00	84	41500.	112.00
85	42000.	112.00	86	42500.	112.00
87	43000.	112.00	88	43500.	112.00
89	44000.	112.00	90	44500.	112.00
91	45000.	112.00	92	45500.	112.00
93	46000.	112.00	94	46500.	112.00
95	47000.	112.00	96	47500.	112.00
97	48000.	112.00	98		112.00
99	49000.	112.00	100		112.00
101	50000.	.00	102	50500.	.00
103	51000.	.00	104	51500.	.00
105	52000.	.00	106	52500.	.00

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111	55000.	.00	112	55500.	.00
113	56000.	.00	114	56500.	.00
115	57000.	.00	116	57500.	.00
117	58000.	.00	118	58500.	.00
119	59000.	.00	120	59500.	.00
121	60000.	.00	122	60500.	.00
123	61000.	.00	124	61500.	.00
125	62000.	.00	126	62500.	.00
127	63000.	.00	128	63500.	.00
129	64000.	.00	130	64500.	.00
131	65000.	.00	132	65500.	.00
133	66000.	.00	134	66500.	.00
135	67000.	.00	136	67500.	.00
137	68000.	.00	138	68500.	.00
139	69000.	.00	140	69500.	.00
141	70000.	.00	142	70500.	.00
143	71000.	.00	144	71500.	.00
145	72000.	.00	146	72500.	.00
147	73000.	.00	148	73500.	.00
149	74000.	.00	150	74500.	.00
151	75000.	.00	152	75500.	.00
153	76000.	.00	154	76500.	.00
155	77000.	.00	156	77500.	.00
157	78000.	.00	158	78500.	.00
159	79000.	.00	160	79500.	.00
161	80000.	.00	162	80500.	.00
163	81000.	.00	164	81500.	.00
165	82000.	.00	166	82500.	.00
167	83000.	.00	168	83500.	.00
169	84000.	.00	170	84500.	.00
171	85000.	.00	172	85500.	.00
173	86000.	.00	174	86500.	.00
175	87000.	.00	176	87500.	.00
177	88000.	.00	178	88500.	.00
179	89000.	.00	180	89500.	.00

100 116 .000 .084 .000 -.542 -.542 .084 .000

TIME = 1 YEARS

1	-2.00	2	-2.00	3	-2.00	4	-2.00	5	-2.00	6	-2.00
7	-2.00	8	-2.00	9	-2.00	10	-2.00	11	-2.00	12	-2.00
13	-2.00	14	-2.00	15	-2.00	16	-2.00	17	-2.00	18	-2.00
19	-2.00	20	-2.00	21	-2.00	22	-2.00	23	-2.00	24	-2.00
25	-2.00	26	-2.00	27	-2.00	28	-2.00	29	-2.00	30	-2.00
31	-2.00	32	-2.00	33	-2.00	34	-2.00	35	-2.00	36	-2.00
37	-2.00	38	-2.00	39	-2.00	40	-2.00	41	-2.00	42	-2.00
43	-2.00	44	-2.00	45	-2.00	46	-2.00	47	-2.00	48	-2.00
49	-2.00	50	-2.00	51	-2.00	52	-2.00	53	-2.00	54	-2.00
55	-2.00	56	-2.00	57	-2.00	58	-2.00	59	-1.99	60	-1.98
61	-1.96	62	-1.93	63	-1.87	64	-1.77	65	-1.60	66	-1.31
67	-.87	68	-.18	69	.84	70	2.31	71	4.34	72	7.07
73	10.62	74	15.06	75	20.45	76	26.75	77	33.87	78	41.64
79	49.83	80	58.16	81	66.34	82	74.10	83	81.19	84	87.43
85	92.71	86	96.98	87	100.24	88	102.52	89	103.87	90	104.31
91	103.87	92	102.52	93	100.24	94	96.98	95	92.71	96	87.43
97	81.19	98	74.10	99	66.34	100	58.16	101	49.83	102	41.64
103	33.87	104	26.75	105	20.45	106	15.06	107	10.62	108	7.07
109	4.34	110	2.31	111	.84	112	-.18	113	-.87	114	-1.31
115	-1.60	116	-1.77	117	-1.87	118	-1.93	119	-1.96	120	-1.98
121	-1.99	122	-2.00	123	-2.00	124	-2.00	125	-2.00	126	-2.00
127	-2.00	128	-2.00	129	-2.00	130	-2.00	131	-2.00	132	-2.00
133	-2.00	134	-2.00	135	-2.00	136	-2.00	137	-2.00	138	-2.00
139	-2.00	140	-2.00	141	-2.	[illegible]	-2.00	143	-2.00	144	-2.00
145	-2.00	146	-2.00	147	-2.	[illegible]	-2.00	149	-2.00	150	-2.00
151	-2.00	152	-2.00	153	-2.00	154	-2.00	155	-2.00	156	-2.00
157	-2.00	158	-2.00	159	-2.00	160	-2.00	161	-2.00	162	-2.00
163	-2.00	164	-2.00	165	-2.00	166	-2.00	167	-2.00	168	-2.00

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175   -2.00 176   -2.00 177   -2.00 178   -2.00 179   -2.00 180   -2.00
     LCUR =      1  PCT(LCUR) =      .78
     LCUR =      2  PCT(LCUR) =      .68
     LCUR =      3  PCT(LCUR) =      .60
     LCUR =      4  PCT(LCUR) =      .53
                    TIME =       5  YEARS
  1  -10.00   2  -10.00   3  -10.00   4  -10.00   5  -10.00   6  -10.00
  7  -10.00   8  -10.00   9  -10.00  10  -10.00  11  -10.00  12  -10.00
 13  -10.00  14  -10.00  15  -10.00  16  -10.00  17  -10.00  18  -10.00
 19  -10.00  20  -10.00  21  -10.00  22  -10.00  23  -10.00  24  -10.00
 25  -10.00  26  -10.00  27  -10.00  28  -10.00  29  -10.00  30  -10.00
 31  -10.00  32  -10.00  33   -9.99  34   -9.99  35   -9.99  36   -9.98
 37   -9.98  38   -9.97  39   -9.96  40   -9.94  41   -9.92  42   -9.90
 43   -9.86  44   -9.82  45   -9.77  46   -9.70  47   -9.61  48   -9.50
 49   -9.37  50   -9.21  51   -9.00  52   -8.76  53   -8.46  54   -8.10
 55   -7.68  56   -7.17  57   -6.58  58   -5.89  59   -5.09  60   -4.17
 61   -3.12  62   -1.93  63    -.59  64     .91  65    2.57  66    4.40
 67    6.41  68    8.58  69   10.91  70   13.41  71   16.05  72   18.82
 73   21.71  74   24.70  75   27.75  76   30.84  77   33.93  78   37.00
 79   40.01  80   42.92  81   45.69  82   48.29  83   50.69  84   52.84
 85   54.71  86   56.29  87   57.54  88   58.45  89   59.00  90   59.18
 91   59.00  92   58.45  93   57.54  94   56.29  95   54.71  96   52.84
 97   50.69  98   48.29  99   45.69 100   42.92 101   40.01 102   37.00
103   33.93 104   30.84 105   27.75 106   24.70 107   21.71 108   18.82
109   16.05 110   13.41 111   10.91 112    8.58 113    6.41 114    4.40
115    2.57 116     .91 117    -.59 118   -1.93 119   -3.12 120   -4.17
121   -5.09 122   -5.89 123   -6.58 124   -7.17 125   -7.68 126   -8.10
127   -8.46 128   -8.76 129   -9.00 130   -9.21 131   -9.37 132   -9.50
133   -9.61 134   -9.70 135   -9.77 136   -9.82 137   -9.86 138   -9.90
139   -9.92 140   -9.94 141   -9.96 142   -9.97 143   -9.98 144   -9.98
145   -9.99 146   -9.99 147   -9.99 148  -10.00 149  -10.00 150  -10.00
151  -10.00 152  -10.00 153  -10.00 154  -10.00 155  -10.00 156  -10.00
157  -10.00 158  -10.00 159  -10.00 160  -10.00 161  -10.00 162  -10.00
163  -10.00 164  -10.00 165  -10.00 166  -10.00 167  -10.00 168  -10.00
169  -10.00 170  -10.00 171  -10.00 172  -10.00 173  -10.00 174  -10.00
175  -10.00 176  -10.00 177  -10.00 178  -10.00 179  -10.00 180  -10.00
     LCUR =      5  PCT(LCUR) =      .47
     LCUR =      6  PCT(LCUR) =      .42
     LCUR =      7  PCT(LCUR) =      .38
     LCUR =      8  PCT(LCUR) =      .33
     LCUR =      9  PCT(LCUR) =      .30
                    TIME =      10  YEARS
  1  -20.00   2  -20.00   3  -20.00   4  -20.00   5  -20.00   6  -20.00
  7  -20.00   8  -20.00   9  -20.00  10  -20.00  11  -20.00  12  -20.00
 13  -19.99  14  -19.99  15  -19.99  16  -19.99  17  -19.99  18  -19.98
 19  -19.98  20  -19.97  21  -19.97  22  -19.96  23  -19.95  24  -19.94
 25  -19.92  26  -19.91  27  -19.89  28  -19.86  29  -19.83  30  -19.80
 31  -19.76  32  -19.71  33  -19.65  34  -19.59  35  -19.51  36  -19.42
 37  -19.31  38  -19.19  39  -19.05  40  -18.89  41  -18.70  42  -18.49
 43  -18.25  44  -17.98  45  -17.68  46  -17.34  47  -16.96  48  -16.53
 49  -16.05  50  -15.53  51  -14.95  52  -14.32  53  -13.62  54  -12.86
 55  -12.04  56  -11.15  57  -10.19  58   -9.16  59   -8.06  60   -6.88
 61   -5.64  62   -4.33  63   -2.96  64   -1.51  65    -.01  66    1.54
 67    3.15  68    4.80  69    6.48  70    8.19  71    9.92  72   11.66
 73   13.40  74   15.12  75   16.82  76   18.48  77   20.10  78   21.66
 79   23.14  80   24.55  81   25.85  82   27.06  83   28.14  84   29.10
 85   29.93  86   30.62  87   31.16  88   31.55  89   31.79  90   31.87
 91   31.79  92   31.55  93   31.16  94   30.62  95   29.93  96   29.10
 97   28.14  98   27.06  99   25.85 100   24.55 101   23.14 102   21.66
103   20.10 104   18.48 105   16.82 106   15.12 107   13.40 108   11.66
109    9.92 110    8.19 111    6[illegible]      4.80 113    3.15 114    1.54
115    -.01 116   -1.51 117   -2[illegible]     -4.33 119   -5.64 120   -6.88
121   -8.06 122   -9.16 123  -10.19 124  -11.15 125  -12.04 126  -12.86
127  -13.62 128  -14.31 129  -14.95 130  -15.53 131  -16.05 132  -16.53
133  -16.96 134  -17.34 135  -17.68 136  -17.98 137  -18.25 138  -18.49
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145   -19.51 146   -19.59 147   -19.65 148   -19.71 149   -19.76 150   -19.80
151   -19.83 152   -19.86 153   -19.89 154   -19.91 155   -19.92 156   -19.94
157   -19.95 158   -19.96 159   -19.97 160   -19.97 161   -19.98 162   -19.98
163   -19.99 164   -19.99 165   -19.99 166   -19.99 167   -19.99 168   -20.00
169   -20.00 170   -20.00 171   -20.00 172   -20.00 173   -20.00 174   -20.00
175   -20.00 176   -20.00 177   -20.00 178   -20.00 179   -20.00 180   -20.00
      LCUR =      10   PCT(LCUR) =        .26
      LCUR =      11   PCT(LCUR) =        .23
      LCUR =      12   PCT(LCUR) =        .19
      LCUR =      13   PCT(LCUR) =        .16
      LCUR =      14   PCT(LCUR) =        .13
      LCUR =      15   PCT(LCUR) =        .10
      LCUR =      16   PCT(LCUR) =        .08
      LCUR =      17   PCT(LCUR) =        .05
      LCUR =      18   PCT(LCUR) =        .02
      LCUR =      19   PCT(LCUR) =        .00
      LCUR =      20   PCT(LCUR) =       -.03
      LCUR =      21   PCT(LCUR) =       -.05
      LCUR =      22   PCT(LCUR) =       -.08
      LCUR =      23   PCT(LCUR) =       -.10
      LCUR =      24   PCT(LCUR) =       -.13
      LCUR =      25   PCT(LCUR) =       -.15
      LCUR =      26   PCT(LCUR) =       -.17
      LCUR =      27   PCT(LCUR) =       -.20
      LCUR =      28   PCT(LCUR) =       -.22
      LCUR =      29   PCT(LCUR) =       -.24
                       TIME =        30  YEARS
  1   -59.99   2   -59.92   3   -59.84   4   -59.76   5   -59.68   6   -59.60
  7   -59.52   8   -59.43   9   -59.34  10   -59.24  11   -59.14  12   -59.04
 13   -58.93  14   -58.82  15   -58.69  16   -58.56  17   -58.43  18   -58.28
 19   -58.13  20   -57.97  21   -57.80  22   -57.62  23   -57.42  24   -57.22
 25   -57.01  26   -56.78  27   -56.54  28   -56.29  29   -56.02  30   -55.75
 31   -55.45  32   -55.15  33   -54.83  34   -54.49  35   -54.14  36   -53.78
 37   -53.40  38   -53.00  39   -52.59  40   -52.17  41   -51.72  42   -51.27
 43   -50.80  44   -50.31  45   -49.81  46   -49.30  47   -48.77  48   -48.23
 49   -47.68  50   -47.11  51   -46.54  52   -45.95  53   -45.36  54   -44.76
 55   -44.15  56   -43.53  57   -42.91  58   -42.28  59   -41.66  60   -41.03
 61   -40.40  62   -39.77  63   -39.15  64   -38.53  65   -37.92  66   -37.31
 67   -36.71  68   -36.13  69   -35.55  70   -34.99  71   -34.45  72   -33.92
 73   -33.41  74   -32.92  75   -32.46  76   -32.01  77   -31.59  78   -31.19
 79   -30.83  80   -30.49  81   -30.17  82   -29.89  83   -29.64  84   -29.42
 85   -29.24  86   -29.08  87   -28.97  88   -28.88  89   -28.83  90   -28.81
 91   -28.83  92   -28.88  93   -28.97  94   -29.08  95   -29.24  96   -29.42
 97   -29.64  98   -29.89  99   -30.17 100   -30.49 101   -30.83 102   -31.19
103   -31.59 104   -32.01 105   -32.45 106   -32.92 107   -33.41 108   -33.92
109   -34.45 110   -34.99 111   -35.55 112   -36.13 113   -36.71 114   -37.31
115   -37.92 116   -38.53 117   -39.15 118   -39.77 119   -40.40 120   -41.03
121   -41.66 122   -42.28 123   -42.91 124   -43.53 125   -44.15 126   -44.76
127   -45.36 128   -45.95 129   -46.54 130   -47.11 131   -47.68 132   -48.23
133   -48.77 134   -49.30 135   -49.81 136   -50.31 137   -50.80 138   -51.27
139   -51.72 140   -52.16 141   -52.59 142   -53.00 143   -53.40 144   -53.78
145   -54.14 146   -54.49 147   -54.83 148   -55.15 149   -55.45 150   -55.74
151   -56.02 152   -56.28 153   -56.54 154   -56.77 155   -57.00 156   -57.21
157   -57.42 158   -57.61 159   -57.79 160   -57.96 161   -58.12 162   -58.27
163   -58.41 164   -58.55 165   -58.68 166   -58.80 167   -58.91 168   -59.02
169   -59.12 170   -59.21 171   -59.31 172   -59.39 173   -59.48 174   -59.56
175   -59.63 176   -59.71 177   -59.78 178   -59.85 179   -59.92 180   -59.99
      LCUR =      30   PCT(LCUR) =       -.26
```

CASE B - NOURISHMENT WITH STRUCTURES PRESENT

In this case, all of the description presented for Case A is relevant with the exceptions noted below. Because Steps 1, 2, 3, and 4 are identical, they will not be repeated here.

STEP 4B - Specify a Reference Background Transport

As has been described earlier, in situations where structures are present, it is necessary to establish the net background longshore transport rate as this will interact with the structure. The net longshore background transport on the east coast of Florida could be estimated from Figure 30. Since background transport rates on the west coast are so variable spatially, no attempt will be made here to provide a recommendation. Rather, it is suggested that each rate should be developed on a case-by-case basis.

The background transport rate is specified to the program on Card 3 as QBKREF and the grid index value associated with the background transport rate QBKREF is specified as IREF on Card 3. Note that QREF must be specified in units of ft^3/second and that the conversion factor from cubic yards per year to cubic feet per second is

$$Q(\text{cubic feet per second}) = 8.56 \times 10^{-7}\, Q(\text{cubic yards per year})$$

STEP 5B - Specify Structure Location(s) and Length(s) in Program

In the current version of the program, up to 10 structures can be specified including the grid line and length. The structures interact with the background sediment transport and the transport induced by the beach nourishment project.

Specification of the structure number, location and length is by Card 4 (this card present only if structures are specified).

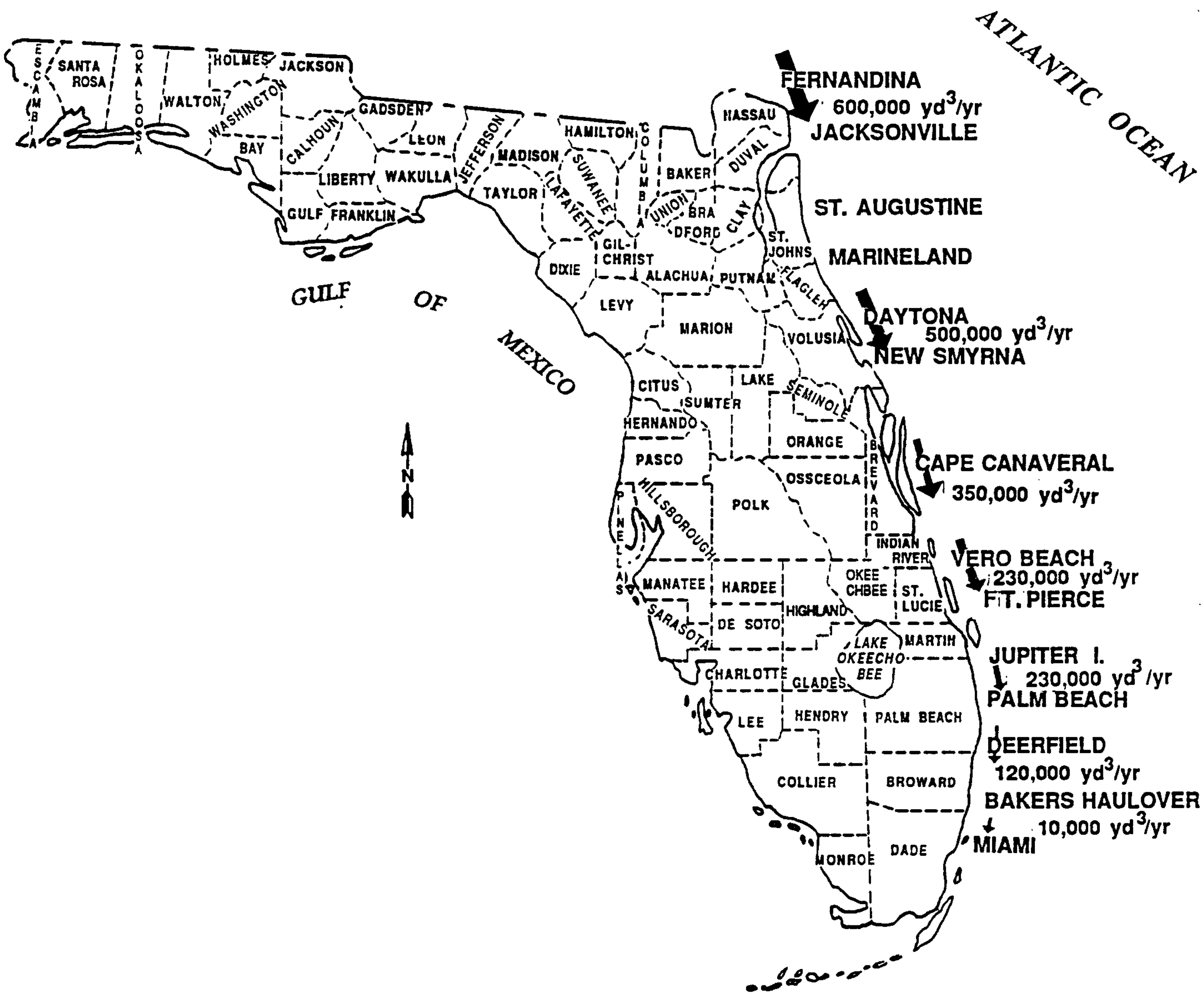

Figure 30. Estimates of Net Annual Longshore Sediment Transport Along Florida's East Coast.

EXAMPLES ILLUSTRATING APPLICATION OF METHODOLOGIES

In this section, a number of examples are presented illustrating application of the methodologies. The purpose of these examples is to familiarize the reader thoroughly with the methodologies and the anticipated results. As in preceding sections of this report, the examples will be organized by "Graphical Methodology" and "Numerical Methodology".

Graphical Example

The following four examples illustrate application of the methodology to the following situations.

Graphical Example 1: Uninterrupted Shoreline, No Background Erosion

Graphical Example 2: Uninterrupted Shoreline, Uniform Background Erosion

Graphical Example 3: Uninterrupted Shoreline; Non-Uniform Background Erosion

Graphical Example 4: Downdrift of a Littoral Barrier, Non-Uniform Background Erosion

The computations and results are presented on the following four worksheets.

Numerical Examples

A number of examples were run with the numerical methodology and are described briefly on the following page. Because the documentation for each example is fairly extensive, each example is presented in an individual appendix.

Numerical Example 1: Uninterrupted Shoreline, No Background Erosion, Nourishment Length = 2 Miles, Initial Added Width = 112 ft, Wave Height = 2.0 ft, Waves Normally Incident, Results Presented in Appendix C.

Numerical Example 2: Uninterrupted Shoreline, Uniform Background Erosion of 2 ft/yr, Nourishment Length = 2 Miles, Initial Added Width = 112 ft, Wave Height = 2.0 ft, Waves Normally Incident, Results Presented in Appendix D.

Numerical Example 3: Uninterrupted Shoreline, Variable Background Erosion, Nourishment Length of 2 Miles, Initial Added Width = 112 ft, Wave Height = 2.0 ft, Waves Normally Incident, Results Presented in Appendix E.

Numerical Example 4: Uninterrupted Shoreline, No Background Erosion, Nourishment Length = 3,500 ft, Wave Height = 2.0 ft, Waves Normally Incident, Results Presented in Appendix F.

Numerical Example 5: One Structure 112 ft Long Located at North End of Nourishment Project, Nourishment Length = 2 Miles, Initial Added Width = 112 ft, Wave Height = 2.0 ft, Waves Normally Incident, No Background Erosion, Results Presented in Appendix G.

Numerical Example 6: One Structure 112 ft Long Located at South End of Nourishment Project, Uniform Background Erosion of 2 ft/yr, Waves Normally Incident, Nourishment Length = 2 Miles, Initial Added Width = 112 ft, Wave Height = 2.0 ft, Results Presented in Appendix H.

Numerical Example 7: One Structure 112 ft Long Located at South End of Nourishment Project, Waves Approaching at 10° Angle to Shoreline, Variable Background Erosion, Nourishment Length = 2 Miles, Initial Added Width = 112 ft, Wave Height = 2.0 ft, Results Presented in Appendix I.

For each numerical example, the input file, DNRBS.INP, and output file, DNRBS.OUT, are presented and the results are discussed and plotted.

GRAPHICAL EXAMPLE 1
(Zero Background Erosion)

BEACH NOURISHMENT PROJECTION
(Graphical Computations, Uninterrupted Shoreline)

General Location: ____________

Wave Height, H_0 (Fig. 23): 2.0 ft, Closure Depth, h_* (Fig. 8): 17 ft
Wave Period, T (Fig. 24): 6 sec, Sediment Size, D: ______ mm
Wave Direction, α_0: 0 °, Transport Factor, K (Fig. 5): 0.77
Berm Height, B: 6 ft

Alongshore Diffusivity, G (From Equation below or Figure 15).

$$G = \frac{K}{8}\frac{H_0^{2.4}C_{G_0}^{1.2}g^{0.4}\cos(\beta_0-\alpha_0)\cos 2(\beta_0-\alpha_*)}{(s-1)(1-p)C_*\kappa^{0.4}(h_*+B)\cos(\beta_0-\alpha_*)}$$

$$= \frac{0.77\ 2^{2.4}(15.36)^{1.2}(32.2)^{0.4}}{8\ (1.65)(0.65)(21.1)(0.78)^{0.4}23.0} = 0.1147\ \text{ft}^2/s$$

Background Erosion

x	Erosion Rate (ER) ft/yr
—	0.0
—	
—	
—	
—	
—	
—	
—	
—	
—	
—	

Equilibrated Beach Width, Δy_0

A_N (Fig. 7) or From Profile: 0.25 $ft^{1/3}$
A_F (Fig. 7): 0.20 $ft^{1/3}$
Volume Per Unit Length: 5113 ft^3/ft
Δy_0 (Figs. 11 and 12): 112 ft
Project Length, ℓ, = 2.0 miles = 10,560 ft

For 30 years

$$16\frac{Gt}{\ell^2} = 16\frac{G(30\text{x}365\text{x}24\text{x}3600)}{\ell^2} = 15.56 =$$

(1) Distance From Center, x(ft)	(2) $\frac{x}{\ell/2}$	(3) $y\left(\frac{x}{\ell/2}\right)/\Delta y_0$ (Fig. 17)	(4) y_s (ft)	(5) y_B(ft) = 30 x ER	(6) $y_N = y_s - y_B$ (ft)
0.0	0.0	0.28	31.1	0	31.1
5280	1.0	0.26	29.1	0	29.4
10,560	2.0	0.22	24.6	0	24.6

GRAPHICAL EXAMPLE 2
(Uniform Background Erosion)

BEACH NOURISHMENT PROJECTION
(Graphical Computations, Uninterrupted Shoreline)

General Location: ______

Wave Height, H_0 (Fig. 23): 2.0 ft, Closure Depth, h_* (Fig. 8): 17 ft
Wave Period, T (Fig. 24): 6.0 sec, Sediment Size, D: ______ mm
Wave Direction, α_0: 0.0 °, Transport Factor, K (Fig. 5): 0.77
Berm Height, B: 6 ft

Alongshore Diffusivity, G (From Equation below or Figure 15).

$$G = \frac{K}{8}\frac{H_0^{2.4}C_{G_0}^{1.2}g^{0.4}\cos(\beta_0-\alpha_0)\cos 2(\beta_0-\alpha_*)}{(s-1)(1-p)C_*\kappa^{0.4}(h_*+B)\cos(\beta_0-\alpha_*)}$$

= Same as Example 1 = 0.1147 ft²/s

Background Erosion

x	Erosion Rate (ER) ft/yr
-10,560	2.0
+10,560	2.0

Equilibrated Beach Width, Δy_0

A_N (Fig. 7) or From Profile: 0.25 ft$^{1/3}$
A_F (Fig. 7): 0.20 ft$^{1/3}$
Volume Per Unit Length: 5113 ft³/ft
Δy_0 (Figs. 11 and 12): 112 ft
Project Length, ℓ, = 2.0 miles = 10,560 ft

For 30 years

$$16\frac{Gt}{\ell^2} = 16\frac{G(30\text{x}365\text{x}24\text{x}3600)}{\ell^2} = 1556 =$$

(1) Distance From Center, x(ft)	(2) $\frac{x}{\ell/2}$	(3) $y\left(\frac{x}{\ell/2}\right)/\Delta y_0$ (Fig. 17)	(4) y_s (ft)	(5) y_B(ft) = 30 x ER	(6) $y_N = y_s - y_B$ (ft)
0	0.0	0.28	31.4	60	-28.6
5280	1.0	0.26	29.1	60	-30.9
10560	2.0	0.22	24.6	60	-35.4

GRAPHICAL EXAMPLE 3
(Non-Uniform Erosion)

BEACH NOURISHMENT PROJECTION
(Graphical Computations, Uninterrupted Shoreline)

General Location: ______________

Wave Height, H_0 (Fig. 23): 2.0 ft, Closure Depth, h_* (Fig. 8): 17.0 ft
Wave Period, T (Fig. 24): 6.0 sec, Sediment Size, D: ________ mm
Wave Direction, α_0: 0.0 °, Transport Factor, K (Fig. 5): 0.77
Berm Height, B: 6.0 ft

Alongshore Diffusivity, G (From Equation below or Figure 15).

$$G = \frac{K}{8}\frac{H_0^{2.4}C_{G_0}^{1.2}g^{0.4}\cos(\beta_0-\alpha_0)\cos 2(\beta_0-\alpha_*)}{(s-1)(1-p)C_*\kappa^{0.4}(h_*+B)\cos(\beta_0-\alpha_*)}$$

= Same as Example 1 = 0.1147 ft²/s

Background Erosion

x	Erosion Rate (ER) ft/yr
-10,560	1.0
+10,560	2.0

Equilibrated Beach Width, Δy_0

A_N (Fig. 7) or From Profile: 0.25 ft$^{1/3}$
A_F (Fig. 7): 0.20 ft$^{1/3}$
Volume Per Unit Length: 5113 ft³/ft
Δy_0 (Figs. 11 and 12): 112 ft
Project Length, ℓ, = 2.0 miles = 10,560 ft

For 30 years

$$16\frac{Gt}{\ell^2} = 16\frac{G(30\text{x}365\text{x}24\text{x}3600)}{\ell^2} = 15.56 =$$

(1)	(2)	(3)	(4)	(5)	(6)
Distance From Center, x(ft)	$\frac{x}{\ell/2}$	$y\left(\frac{x}{\ell/2}\right)/\Delta y_0$ (Fig. 17)	y_s (ft)	y_B(ft) = 30 x ER	$y_N = y_s - y_B$ (ft)
-10,560	-2	0.22	24.6	30.0	-5.4
-5,280	-1	0.26	29.1	37.5	-8.4
0	0	0.28	31.4	45.0	-13.6
+5280	+1	0.26	29.1	52.5	-23.4
+10,560	+2	0.22	24.6	60.0	-35.4

GRAPHICAL EXAMPLE 4
(Non-Uniform Erosion)

BEACH NOURISHMENT PROJECTION
(Graphical Computations, Downdrift of a Littoral Barrier)

General Location: ____________

Wave Height, H_0 (Fig. 23): 2.0 ft, Closure Depth, h_* (Fig. 8): 17.0 ft
Wave Period, T (Fig. 24): 6.0 sec, Sediment Size, D: ______ mm
Wave Direction, α_0: 0 °, Transport Factor, K (Fig. 5): 0.77
Berm Height, B: 6.0 ft

Alongshore Diffusivity, G(From Equation Below or Figure 15)

$$G = \frac{K}{8}\frac{H_0^{2.4}C_{G_0}^{1.2}g^{0.4}\cos(\beta_0-\alpha_0)\cos 2(\beta_0-\alpha_*)}{(s-1)(1-p)C_*\kappa^{0.4}(h_*+B)\cos(\beta_0-\alpha_*)}$$

= Same = 0.1147 ft^2/s

Background Erosion

x	Erosion Rate	(ER)
0	-20.0	ft/yr
5280	-16.0	
10560	-8.0	
21120	-4.0	

Equilibrated Beach Width, Δy_0

A_N (Fig. 7) or From Profile: 0.25 $ft^{1/3}$
A_F (Fig. 7): 0.20 $ft^{1/3}$
Volume Per Unit Length: 5113 ft^3/ft
Δy_0 (Figs. 11 and 12): 112 ft
Project Length, ℓ, = ____ miles = 10,560 ft
Effective Project Length, $\ell' = 2\ell$ = ____ miles = 21,120 ft

For 30 years

$$16\frac{Gt}{(\ell')^2} = 16\frac{G(30x365x24x3600)}{(\ell')^2} = 3.89 =$$

(1)	(2)	(3)	(4)	(5)	(6)
Distance From Littoral Barrier, x(ft)	$\frac{x}{\ell'/2}$	$y\left(\frac{x}{\ell'/2}\right)/\Delta y_0$ (Fig. 17)	y_s (ft)	y_B(ft) = 30 x ER	$y_N = y_s - y_b$ (ft)
0	0	0.52	58.2	600	-542
5280	0.5	0.50	56.0	480	-424
10560	1.0	0.42	47.0	240	-192
21120	2.0	0.22	24.6	120	-95

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Pelnard Considere, R. (1956) "Essai de Theorie de l'Evolution des Formes de Rivate en Plages de Sable et de Galets", 4th Journees de l'Hydraulique, Les Engergies de la Mar, Question III, Rapport No. 1.

APPENDIX A

DEEP WATER WAVE EQUIVALENTS

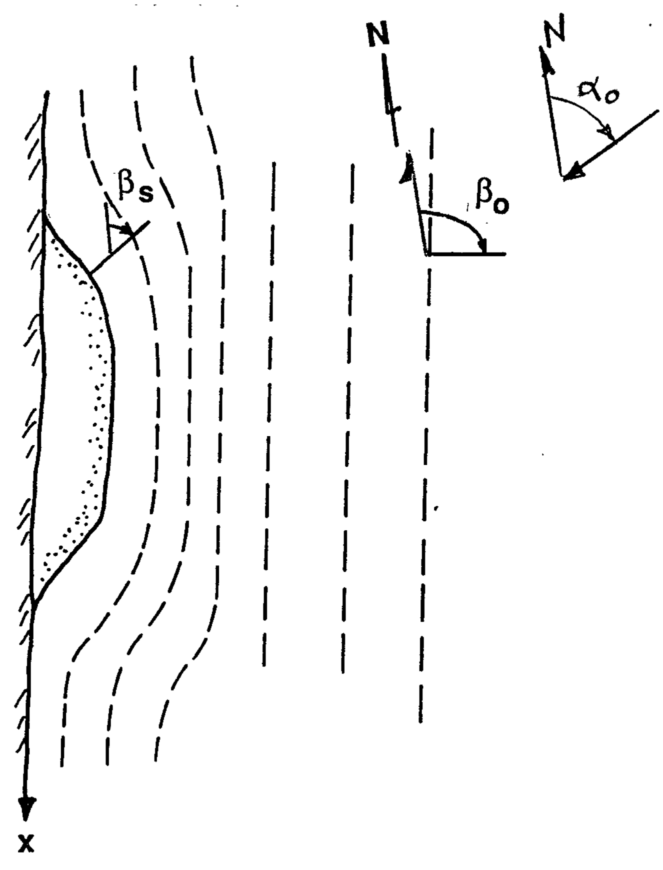
FOR SHORELINE MODELING

APPENDIX A

DEEP WATER WAVE EQUIVALENTS FOR SHORELINE MODELING

Consider the transport equation

$$Q = K\frac{E_b C_{G_b}\cos(\beta_s - \alpha_b)\sin(\beta_s - \alpha_b)}{\rho g(s-1)(1-p)} \qquad \text{(A.1)}$$



Definition Sketch

The bathymetry of concern will be considered as straight and parallel bottom contours seaward of the effects of a beach nourishment project. This seaward depth limit is denoted as h_*. For depths smaller than h_*, it is assumed that all contours are parallel to the shoreline. The azimuth, β_s, of the outward normal within the depth limit affected by the nourishment project is related to the azimuth of the outward normal, β_0, outside the limit of the project by

$$\beta_s(x) = \beta_0 + \Delta\beta(x) \tag{A.2}$$

in which $\Delta\beta$ is small.

Using conservation of energy and Snell's law to transform Eq. (A.1) from the breaker line to the depth contour h_*,

$$Q = K\frac{E_* C_{G_*} \cos(\beta_s - \alpha_*) \sin(\beta_s - \alpha_*)}{\rho g(s-1)(1-p)C_*} C_b \tag{A.3}$$

and using Eq. (A.2)

$$Q = \frac{K\,E_*}{2}\frac{C_{G_*} \sin 2(\beta_0 + \Delta\beta - \alpha_*)}{\rho g(s-1)(1-p)}\frac{C_b}{C_*} \tag{A.4}$$

and expanding

$$\begin{aligned} Q &= K\frac{E_*}{2}\frac{C_{G_*} \sin 2(\beta_0 - \alpha_*)}{\rho g(s-1)(1-p)} \cos 2\Delta\beta \frac{C_b}{C_*} \\ &+ K\frac{E_*}{2}\frac{C_{G_*} \cos 2(\beta_0 - \alpha_*)}{\rho g(s-1)(1-p)} \sin 2\Delta\beta \frac{C_b}{C_*} \end{aligned} \tag{A.5}$$

Since $\Delta\beta$ is small, $\cos 2\Delta\beta \approx 1$ and $\sin 2\Delta\beta \approx 2\Delta\beta$, and the first term is recognized as the transport without the project present (the background transport, Q_B) and the second term the transport induced by project placement, Q_P.

The background transport will first be expressed in terms of deep water wave characteristics

$$\begin{aligned} Q_{\mathrm{BACKGROUND}} = Q_B &= K\frac{E_* C_{G_*} \cos(\beta_0 - \alpha_*) \sin(\beta_0 - \alpha_*)}{\rho g(s-1)(1-p)}\frac{C_b}{C_*} \\ &= \frac{K\,E_0 C_{G_0} \cos(\beta_0 - \alpha_0) \sin(\beta_0 - \alpha_0)}{\rho g(s-1)(1-p)}\frac{C_b}{C_0} \end{aligned} \tag{A.6}$$

Eq. (A.6) contains C_b which we now wish to relate to deep water conditions. Using energy conservation,

$$E_b C_{G_b} \cos(\beta_s - \alpha_b) = E_* C_{G_*} \cos(\beta_s - \alpha_*) = E_* C_{G_*} \cos(\beta_0 + \Delta\beta - \alpha_*)$$

Therefore

$$E_b C_{G_b} \cos(\beta_s - \alpha_b) = E_* C_{G_*}[\cos(\beta_0 - \alpha_*) \cos \Delta\beta - \sin(\beta_* - \alpha_*) \sin \Delta\beta]$$

and since $\Delta\beta$ is small, the last term can be neglected and $\cos \Delta\beta \approx 1$. Finally

$$E_b C_{G_b} \cos(\beta_s - \alpha_b) \approx E_0 C_{G_0} \cos(\beta_0 - \alpha_0)$$

and employing the following shallow water approximations

$$C_{G_b} \approx C_b \approx \sqrt{g h_b}$$

$$H_b \approx \kappa h_b \quad , \quad (\kappa \approx 0.78)$$

$$g^2 H_b^2 C_b \cos(\beta_s - \alpha_b) = g^2 H_0^2 C_{G_0} \cos(\beta_0 - \alpha_0)$$

$$\kappa^2 C_b^5 \cos(\beta_s - \alpha_b) = g^2 H_0^2 C_{G_0} \cos(\beta_0 - \alpha_0)$$

$$C_b = \left[\frac{g^2 H_0^2 C_{G_0} \cos(\beta_0 - \alpha_0)}{\kappa^2}\right]^{0.2} \qquad \text{(A.7)}$$

in which $\cos(\beta_s - \alpha_b)$ has been approximated by unity.

Returning now to the project transport and using conservation of energy considerations and Snell's law to transform to deep water

$$Q_P = \frac{K\, E_0 C_{G_0} \cos 2(\beta_0 - \alpha_*) \cos(\beta_0 - \alpha_0)}{\rho g (s-1)(1-p) \cos(\beta_0 - \alpha_*)} \Delta\beta \frac{C_b}{C_*} \qquad \text{(A.8)}$$

Employing Eq. (A.7), the project related transport can now be written without reference to shallow water

$$Q_P = \frac{K\, H_0^{2.4} C_{G_0}^{1.2} g^{0.4} \cos^{1.2}(\beta_0 - \alpha_0)}{8(s-1)(1-p) \cos(\beta_0 - \alpha_*) \kappa^{0.4}} \cos 2(\beta_0 - \alpha_*) \frac{1}{C_*} \Delta\beta \qquad \text{(A.9)}$$

Using Snell's law,

$$\beta_0 - \alpha_* = \sin^{-1}\left[\frac{C_*}{C_0} \sin(\beta_0 - \alpha_0)\right] \qquad \text{(A.10)}$$

The shore planform direction anomaly $\Delta\beta$ is

$$\Delta\beta = -\tan^{-1}\left(\frac{\partial y}{\partial x}\right) \approx -\frac{\partial y}{\partial x} \qquad \text{(A.11)}$$

Combining Eqs. (A.8) and (A.11) with the continuity equation

$$\frac{\partial y}{\partial t} = -\frac{1}{(h_* + B)} \frac{\partial Q_P}{\partial x} \tag{A.12}$$

we find

$$\frac{\partial y}{\partial t} = \frac{K\, H_0^{2.4} C_{G_0}^{1.2} g^{0.4}}{8(s-1)(1-p)C_* \kappa^{0.4}(h_* + B)} \left[\frac{\cos^{1.2}(\beta_0 - \alpha_0)\cos 2(\beta_0 - \alpha_*)}{\cos(\beta_0 - \alpha_*)}\right] \frac{\partial^2 y}{\partial x^2}$$

Defining the longshore diffusivity,

$$G = \frac{K\, H_0^{2.4} C_{G_0}^{1.2} g^{0.4}}{8(s-1)(1-p)C_* \kappa^{0.4}(h_* + B)} \left[\frac{\cos^{1.2}(\beta_0 - \alpha_0)\cos 2(\beta_0 - \alpha_*)}{\cos(\beta_0 - \alpha_*)}\right] \tag{A.13}$$

and it is noted that G is now expressed entirely in terms of deep water wave quantities (with the use of Eq. (A.10)). The diffusion equation for shoreline evolution is obtained in the usual form

$$\frac{\partial y}{\partial t} = G \frac{\partial^2 y}{\partial x^2} \tag{A.14}$$

We now consider the equations that will be used for numerical analysis. Commencing with Eq. (A.3) and inserting Eq. (A.2) in the cosine term

$$Q = \frac{K\, E_* C_{G_*}[\cos(\beta_0 - \alpha_*)\cos\Delta\beta - \sin(\beta_0 - \alpha_*)\sin\Delta\beta]}{\rho g(s-1)(1-p)C_*} \sin(\beta_s - \alpha_*) C_b \tag{A.15}$$

and since $\Delta\beta$ is small and using conservation of energy

$$Q = \frac{K\, E_0 C_{G_0}\cos(\beta_0 - \alpha_0)}{\rho g(s-1)(1-p)C_*} \sin(\beta_s - \alpha_*) C_b \tag{A.16}$$

Combining Eq. (A.7) with the expression for deep water wave energy, E_0

$$E_0 = \frac{\rho g\, H_0^2}{8} \tag{A.17}$$

yields

$$Q = \frac{K\, H_0^{2.4} C_{G_0}^{1.2} g^{0.4} \cos^{1.2}(\beta_0 - \alpha_0)}{8(s-1)(1-p)C_* \kappa^{0.4}} \sin(\beta_s - \alpha_*) \tag{A.18}$$

and

$$\alpha_* = \beta_0 - \sin^{-1}\left[\frac{C_*}{C_0}\sin(\beta_0 - \alpha_0)\right] \tag{A.19}$$

which completes the development. It is noted that with the exception of the trigonometric term involving $(\beta_s - \alpha_*)$ and the term C_*, all quantities are expressed in terms of deep water conditions.

Representative Wave Conditions

To simplify input conditions it is desirable to define representative wave characteristics. In developments here, we will consider a constant wave direction, but time-varying wave height and period. At each time, the waves will be considered as represented by a single period and a Rayleigh wave height distribution with significant wave height H_s. The effective height is thus

$$H'_{eff} = \left[\int_0^{\infty} H^{2.4} p(H) dH\right]^{\frac{1}{2.4}} \tag{A.20}$$

in which all wave heights are in deep water and $p(H)$ is the Rayleigh distribution,

$$p(H) = \frac{2H}{H_{rms}^2} e^{-(H/H_{rms})^2} \tag{A.21}$$

Eq. (A.20) can be solved numerically to yield

$$H_{eff} = K_{rms} H_{rms} = K_s H_s \tag{A.22}$$

where $K_{rms} = 1.04$ and $K_s = 0.735$. Thus the long-term effective wave height H_{eff} at a particular location is

$$H_{eff} = \left[\frac{1}{N}\sum_{n=1}^{N} (K_s H_{s_n})^{2.4}\right]^{\frac{1}{2.4}} \tag{A.23}$$

A somewhat more appropriate but more cumbersome value of H_{eff} is

$$H_{eff_2} = \frac{\left[\frac{1}{N}\sum_{n=1}^{N} (K_s H_{s_n})^{2.4} \frac{C_{G_{0n}}^{1.2}}{C_{*n}}\right]^{\frac{1}{2.4}}}{\left[\frac{1}{N}\sum_{n=1}^{N} \frac{C_{G_{0n}}^{1.2}}{C_{*n}}\right]^{\frac{1}{2.4}}} \tag{A.24}$$

and the effective value of $\frac{C_{G_0}^{1.2}}{C_*}$ to be used in Eq. (A.18) is the denominator of Eq. (A.24) raised to the 2.4 power. The recommended values of effective deep water wave height around the state of Florida are plotted in Figure 23.

APPENDIX B

PROGRAM LISTING

AND

SAMPLE INPUT AND OUTPUT

Program:	DNRBS.FOR
Input File:	DNRBS.INP
Output File:	DNRBS.OUT

(Note: Input and Output Files Presented for Numerical Example 2)

PROGRAM LISTING: DNRBS.FOR

```
C
C  ********************************************************************
C    THIS PROGRAM DEVELOPED FOR DIVISION OF BEACHES AND SHORES,
C     DEPARTMANT OF NATURAL RESOURCES FOR USE IN PREDICTING           *
C     THIRTY YEAR EROSION PROJECTIONS                                 **
C  ********************************************************************
C
      DIMENSION YO(500),YN(500),X(500),Q(500),HB(500),ALP(500),
     1          XER(40),EROSB(40),SUMA(50),VTOTA(50),YEARA(50),
     2          ITNOUR(10),ISEG(10),IS(10,10),IE(10,10),DY(10,10),
     3          WORD(20),YEAR(10),DV(10,10),NSEG(10),PCT(50),DYO(500)
     4         ,QBACK(500),YSTRUC(10),ISTRUC(10)
      OPEN(UNIT=6,FILE='DNRBS2.OUT',STATUS='NEW')
      OPEN(UNIT=5,FILE='DNRBS2.INP',STATUS='OLD')
      OPEN(UNIT=7,FILE='DNRBS2.DAT',STATUS='NEW')
   55 FORMAT('***** IT = 1, I=1, EROSION RATE = ',E12.2)
  120 FORMAT(6(I4,F8.2))
  121 FORMAT(/,5X,'NTIME = ',I6,'  HB = ',F8.2,'  ALP = 'F8.3,' SUM = ',
     1     F8.2,'  STDEV = ',F8.2,/)
  122 FORMAT(//)
  123 FORMAT(5F8.2,4I6)
  124 FORMAT(8F8.2)
  125 FORMAT(4(E8.2,F8.2))
  126 FORMAT(20A4)
  127 FORMAT(20A4,/)
  160 FORMAT(8I6)
  162 FORMAT(F8.2,3I6,2F8.2)
  164 FORMAT(8I6)
  165 FORMAT(/)
  166 FORMAT(I6,3F8.2)
  167 FORMAT('  INITIAL SHORELINE (INCL. NOURISHMENT) POSITION',/)
  168 FORMAT(I6,F8.1,2E12.4,F8.2)
  170 FORMAT(' HO =',F6.2,' FT., T =',F6.2,' SEC.,  ALPO = ',F6.2,' DEG.
     1, BTAO = ',F6.2,' DEG., '
     2 ,5X,' XMU =',F8.2,' DEG., DX = ',F8.2,' FT., DT = ',F8.2,' SEC.')
  172 FORMAT(' HSTR = ',F8.2,' FT., B = ',F8.2,' FT., XK = ',F8.2,
     1' VFACT = '   ,F8.2,14X,'QBKREF = ',F8.2,' FT.**3/SEC.')
  173 FORMAT('   IREF = ',I6,', IMAX = ',I6,', NTIMES = ',I8,
     1 ', NS = ',I6)
  444 FORMAT(20X,'TIME = ',I8,'  YEARS')
  446 FORMAT('    NYEARS = ',I8,'   DYSITE = ',F8.2)
  447 FORMAT('   BACKGROUND EROSION TRANSPORT RATES',/)
  448 FORMAT(5(I6,F8.3))
  449 FORMAT(2I6,8F8.3)
      GRAV=32.2
      NER=7
      SG=2.65
      POR=0.35
      PI=3.14159
      PIO2=PI/2.0
      ITNM=1
      XKAP=0.78
      QBACK(1)=0.0
      LCUR=0
      READ(5,126)(WORD(I),I=1,20)
```

```
      WRITE(6,127)(WORD(I),I=1,20)
      WRITE(7,126)(WORD(I),I=1,15)
      READ(5,124)HO,T,ALPO,BTAO,XMU,DX,DT
      READ(5,123)HSTR,B,XK,VFACT,QBKREF,IREF,IMAX,NTIMES,NS
      IF(NS.GT.0)READ(5,448)(ISTRUC(I),YSTRUC(I),I=1,NS)
      WRITE(7,170)HO,T,ALPO,BTAO,XMU,DX,DT
      WRITE(7,172)HSTR,B,XK,VFACT,QBKREF
      WRITE(6,170)HO,T,ALPO,BTAO,XMU,DX,DT
      WRITE(6,172)HSTR,B,XK,VFACT,QBKREF
      WRITE(6,173)IREF,IMAX,NTIMES,NS
      WRITE(6,165)
      IF(NS.GT.0) WRITE(6,448)(ISTRUC(I),YSTRUC(I),I=1,NS)
      ALPO=ALPO*PI/180.0
      BTAO=BTAO*PI/180.0
      XMU=XMU*PI/180.0
      READ(5,124)(XER(I),EROSB(I),I=1,NER)
      WRITE(6,165)
      WRITE(6,125)(XER(I),EROSB(I),I=1,NER)
      WRITE(*,125)(XER(I),EROSB(I),I=1,NER)
      READ(5,160)NNOUS,NNOUE
      WRITE(*,160)NNOUS,NNOUE
      DO 60 I=NNOUS,NNOUE
      READ(5,166)I,DYO(I)
   60 DYO(I)=DYO(I)*VFACT
      TOTH=HSTR+B
      IMM1=IMAX-1
      IMP1=IMAX+1
      DO  30 I=1,IMP1
      X(I)=(I-1)*DX
      YN(I)=0.0
   30 YO(I)=0.0
C**** FOLLOWING IS BACKGROUND EROSION AND ASSOCIATED TRANSPORT
      DO 240 I=1,IMAX
      CALL INTERP(EROSB,ERC,NER,X,XER,I,DT,QBACK,TOTH,DX,IREF)
  240 CONTINUE
      DQ=QBACK(IREF)-QBKREF
      DO 241 I=1,IMP1
  241 QBACK(I)=QBACK(I)-DQ
      CALL WVNUM(HSTR,T,CC)
      CO=GRAV*T/(2.0*PI)
      CGO=CO/2.0
      ALPSTR=BTAO-ASIN(CC/CO*SIN(BTAO-ALPO))
C     WRITE(6,124)HSTR,T,CC,CO,CGO,ALPO,BTAO,ALPSTR
      CALP=COS(ALPO-ALPSTR)
      SALP=SIN(ALPO-ALPSTR)
      WRITE(6,165)
      WRITE(6,447)
      WRITE(6,448)(I,QBACK(I),I=1,IMP1)
      WRITE(6,165)
      WRITE(6,160)NNOUS,NNOUE
      WRITE(6,167)
C *****   FOLLOWING IS TIME LOOP
      DO 300 NT=1,NTIMES
      IF(MOD(NT,10).EQ.0)  WRITE(*,*) NT,NTIMES
      BB=XK*HO**2.4*CGO**1.2*GRAV**0.4*COS(BTAO-ALPO)**1.2/
     1  (8.0*(SG-1)*(1.0-POR)*CC*XKAP**0.4)
      SUM=0.0
      SUM2=0.0
      NFLAG=0
      IF(NFLAG.EQ.1) GO TO 302
      IF(NT.EQ.1.OR.NT.EQ.0) CALL NOUR(NT,ITNM,YO,IMAX,ITNOUR,
     1  NSEG,IS,IE,DY,VTOT,IT,DV,X,NNOUS,NNOUE,DYO,DX,TOTH)
C     YO(1)=0.0
C     YO(IMAX)=0.0
C*****FOLLOWING IS TRANSPORT LOOP
```

```
      BTA=XMU-ATAN2((YO(I)-YO(I-1)),(X(I)-X(I-1)))-PIO2
      COSC=COS(BTA-ALPO)
      SINC=SIN(BTA-ALPO)
      Q(I)=BB*SIN(BTA-ALPSTR)
      QB=QBACK(I)
      QSAVE=Q(I)
      CALL STR(NS,YSTRUC,I,YO,Q,IMAX,DX,ALPC,XMU,QB,BB,PIO2,
     1   ISTRUC,ALPSTR)
      IF(NT.EQ.100.AND.I.EQ.116)WRITE(6,449)NT,I,Q(I),QB,
     1 YSTRUC(1),YO(I-1),YO(I),QBACK(I),QSAVE
      Q(I)=Q(I)+QB
  100 CONTINUE
      YN(1)=YO(1)
      YN(IMAX)=YO(IMAX)
      Q(1)=QBACK(1)+Q(2)-QBACK(2)
      Q(IMP1)=QBACK(IMP1)+Q(IMAX)-QBACK(IMAX)
C******FOLLOWING IS FOR CONTINUITY EQUATION
      DO 200 I=1,IMAX
      IF(I.GT.1)GO TO 266
      DX=X(2)-X(1)
      GO TO 268
  266 DX=(X(I+1)-X(I-1))/2.0
  268 CONTINUE
      AA=YO(I)
      YN(I)=YO(I)-DT/(DX*TOTH)*(Q(I+1)-Q(I))
      YO(I)=YN(I)
      IF(I.NE.1.OR.NT.NE.10)GO TO 200
      WRITE(7,449)I,NT,AA,YN(I),DT,DX,TOTH,Q(I+1),Q(I)
  200 CONTINUE
C     WRITE(6,120)(I,YN(I),I=1,IMP1)
C     WRITE(6,120)(I,Q(I),I=1,IMP1)
      IF(MOD(NT,365).NE.0) GO TO 300
C     IF(MOD(NT,3650).NE.0) GO TO 301
      NYEARS=NT/365
      NZC=NYEARS
      IF(NZC.NE.1.AND.NZC.NE.5.AND.NZC.NE.10.AND.NZC.NE.30)GO TO 301
      WRITE(6,444)NYEARS
      WRITE(6,120)(I,YN(I),I=1,IMAX)
  301 CALL PERCT(YN,DX,SUM,PCT,VTOT,LCUR,LCURM,SUMA,VTOTA,TOTH,X
     1   ,NNOUS,NNOUE)
      YEARA(LCUR)=1990.0+(NT-1)*DT/31536000.0
  300 CONTINUE
      WRITE(7,168)(L,YEARA(L),SUMA(L),VTOTA(L),PCT(L),L=1,LCURM)
      DYSITE=0.5*(YN(26)+YN(27))-62.06-NYEARS*2.31
C     NZC=NYEARS
C     IF(NZC.NE.1.OR.NZC.NE.5.OR.NZC.NE.10.OR.NZC.NE.30)GO TO 302
C     WRITE(6,446)NYEARS,DYSITE
      WRITE(7,120)(I,YN(I),I=1,IMP1)
C     WRITE(6,120)(I,Q(I),I=1,IMP1)
  302 CONTINUE
      CLOSE(UNIT=5)
      CLOSE(UNIT=6)
      CLOSE(UNIT=7)
      STOP
      END
C
C   *********************
C
      SUBROUTINE INTERP(EROSB,ERC,NER,X,XER,I,DT,QBACK,TOTH,DXB,IREF)
      DIMENSION EROSB(40),XER(40),X(400),QBACK(400)
  100 FORMAT(2I6,6F10.3)
  101 FORMAT(6E12.4)
      XC=X(I)
      CON=DT/31536000.0
      DO 10 IER=2,NER
      IF(XC.LT.X(IER-1).OR.XC.GT.XER(IER)) GO TO 10
```

```
      DX=XER(IER)-XER(IER-1)
      DXX=XC-XER(IER-1)
      AA=DXX/DX
      BB=1.0-AA
      ERC=-CON*(BB*EROSB(IER-1)+AA*EROSB(IER))
      QBACK(I+1)=QBACK(I)-DXB*TOTH*ERC/DT
      IF(I.NE.2)GO TO 6
C     WRITE(6,100)I,IER,ERC,DT,TOTH,DX,AA,BB
C     WRITE(6,101)QBACK(I),QBACK(I-1),QBACK(I+1),CON,DXB
    6 GO TO 20
   10 CONTINUE
   20 RETURN
      END
C
C    *********
C
      SUBROUTINE NOUR(NT,ITNM,YN,IMAX,ITNOUR,NSEG,
     1  IS,IE,DY,VTOT,ITC,DV,X,NNOUS,NNOUE,DYO,DX,TOTH)
      DIMENSION YN(500),ITNOUR(10),NSEG(10),DY(10,10),
     1   IS(10,10),IE(10,10),DV(10,10),YNT(500),
     2   X(500),DYO(50)
   24 FORMAT(' OUTPUT FROM SR NOUR ',I6,' ISC = ',I6,' IEC = ',I6)
   26 FORMAT(' REACHED SR NOUR',2I6,F8.2)
   28 FORMAT(' NOUR EVENT = ',I6,' YEAR = ',F8.2,
     1 ' VOL ADDED = ',F8.3,' MILL YDS**3',/)
   30 FORMAT(2(I6,F10.0,F8.2))
   32 FORMAT(' TOTAL VOLUME ADDED = ',F12.1 ,'  CUBIC YARDS',/)
      VTOTT=0.0
      FACT=1.0
C     IF(NT.NE.1)FACT=0.5
      DO 6 I=NNOUS,NNOUE
    6 YN(I)=YN(I)+DYO(I)*FACT
      DO 12 I=NNOUS,NNOUE
   12 VTOTT=VTOTT+(X(I+1)-X(I-1))/2.0*YN(I)
      VTOT=VTOTT
C     WRITE(6,32)VTOT
C     WRITE(7,32)VTOT
      WRITE(6,30)(I,X(I),YN(I),I=1,IMAX)
      RETURN
      END
C
C    ************* THIS SUBROUTINE CALCULATES PERCENTAGES OF
C                  TOTAL VOLUME REMAINING
      SUBROUTINE PERCT(YN,DX,SUM,PCT,VTOT,LCUR,LCURM,SUMA,VTOTA,TOTH,X
     1  ,NNOUS,NNOUE)
      DIMENSION YN(400),PCT(50),SUMA(50),VTOTA(50),X(200)
   24 FORMAT(5X,'LCUR = ',I6,'  PCT(LCUR) = ',F8.2)
      SUM=0.0
      DO 20 I=NNOUS,NNOUE
   20 SUM=SUM+(X(I+1)-X(I-1))/2.0*YN(I)
      LCUR=LCUR+1
      LCURM=LCUR
      SUMA(LCUR)=SUM
      VTOTA(LCUR)=VTOT
      PCT(LCUR)=SUM/VTOT
      WRITE(6,24)LCUR,PCT(LCUR)
      WRITE(*,24)LCUR,PCT(LCUR)
      RETURN
      END
C
C*********THIS SUBROUTINE CHECKS FOR AND ACCOUNTS FOR THE TRANSPORT
C         AROUND STRUCTURES
C
      SUBROUTINE STR(NS,YSTRUC,I,YO,Q,IMAX,DX,ALPC,XMU,QB,BB,PIO2,
     1 ISTRUC,ALPSTR)
```

```
C
   18 FORMAT(3I6,6F8.2)
C     WRITE(*,18)NS,I,I,YSTRUC(1)
      DO 20 IS=1,NS
      IC=IS
   20 IF(I.EQ.ISTRUC(IS))GO TO 40
      GO TO 80
   40 DYP=YO(I)-YSTRUC(IC)
      DYM=YO(I-1)-YSTRUC(IC)
C     WRITE(6,18)I,ISTRUC(IC),IC,DYP,DYM
      DXC=DX/2.0
      IF(DYP.GE.0.0.AND.DYM.GE.0.0)GO TO 80
      IF(DYM.LT.0.0.AND.QB.GT.0.0)QB=0.0
      IF(DYP.LT.0.0.AND.QB.LT.0.0)QB=0.0
      IF(DYM.GE.0.0.OR.DYP.GE.0.0)GO TO 42
      Q(I)=0.0
      GO TO 80
   42 IF(DYM.LT.0.0)GO TO 44
C    TO HERE IF DYM.GT.0.0.AND DYP.LT.0.0
      BTA=XMU-ATAN2(-DYM,DXC)-PIO2
      GO TO 46
C    TO HERE IF DYP.GT.0.0.AND.DYM.LT.0.0
   44 BTA=XMU-ATAN2(DYP,DXC)-PIO2
   46 Q(I)=BB*SIN(BTA-ALPSTR)
   80 RETURN
      END
C
C  ****** THIS SUBROUTINE CALCULATES WAVE LENGTH AND CELERITY
C
      SUBROUTINE WVNUM(HSTR,T,CC)
   20 FORMAT(I6,8F8.3)
      G=32.17
      EPS=0.001
      TWOPI=6.283185
      SIG=TWOPI/T
      XK=TWOPI/(T*SQRT(G*HSTR))
      DO 100 IT=1,20
      ARG=XK*HSTR
      EK=(G*XK*TANH(ARG))-SIG**2
      SECHA=1.0/COSH(ARG)
      EKPR=G*(ARG*(SECHA**2)+TANH(ARG))
      XKNEW=XK-EK/EKPR
      IF(ABS(XKNEW-XK).LT.ABS(EPS*XKNEW)) GO TO 120
      XK=XKNEW
  100 CONTINUE
  120 XK=XKNEW
      XL=TWOPI/XK
      CC=XL/T
      RETURN
      END
```

INPUT FILE: DNRBS.INP
(Example No. 2)

```
  EXAMPLE NO. 2 UNIF. BACK. EROS. NO STRUC. 2 MILE PROJ.
  2.00      6.0     90.0     90.0    180.0    500.0 86400.0
  17.0      6.0     0.77      1.0      0.0      1   180 10950      0
   0.0      2.0   90000.      2.0   49500.      2.0  60000.      3.0
90000.      3.0  100000.      3.0  140000.      2.0
  80   100
  80   112.0
  81   112.0
  82   112.0
  83   112.0
  84   112.0
  85   112.0
  86   112.0
  87   112.0
  88   112.0
  89   112.0
  90   112.0
  91   112.0
  92   112.0
  93   112.0
  94   112.0
  95   112.0
  96   112.0
  97   112.0
  98   112.0
  99   112.0
 100   112.0
```

OUTPUT FILE: DNRBS.OUT
(Example No. 2)

EXAMPLE NO. 2 UNIF. BACK. EROS. NO STRUC. 2 MILE PROJ.

```
 HO =  2.00 FT., T =  6.00 SEC.,  ALPO =  90.00 DEG., BTAO =  90.00 DEG.,
XMU =  180.00 DEG., DX =  500.00 FT., DT = 86400.00 SEC.
 HSTR =    17.00 FT., B =     6.00 FT., XK =      .77 VFACT =     1.00
    QBKREF =      .00 FT.**3/SEC.
   IREF =      1, IMAX =    180, NTIMES =    10950, NS =      0



 .00E+00    2.00 .90E+05    2.00 .50E+05    2.00 .60E+05    3.00
 .90E+05    3.00 .10E+06    3.00 .14E+06    2.00
```

BACKGROUND EROSION TRANSPORT RATES

1	.000	2	.001	3	.001	4	.002	5	.003
6	.004	7	.004	8	.005	9	.006	10	.007
11	.007	12	.008	13	.009	14	.009	15	.010
16	.011	17	.012	18	.012	19	.013	20	.014
21	.015	22	.015	23	.016	24	.017	25	.018
26	.018	27	.019	28	.020	29	.020	30	.021
31	.022	32	.023	33	.023	34	.024	35	.025
36	.026	37	.026	38	.027	39	.028	40	.028
41	.029	42	.030	43	.031	44	.031	45	.032
46	.033	47	.034	48	.034	49	.035	50	.036
51	.036	52	.037	53	.038	54	.039	55	.039
56	.040	57	.041	58	.042	59	.042	60	.043
61	.044	62	.044	63	.045	64	.046	65	.047
66	.047	67	.048	68	.049	69	.050	70	.050
71	.051	72	.052	73	.053	74	.053	75	.054
76	.055	77	.055	78	.056	79	.057	80	.058
81	.058	82	.059	83	.060	84	.061	85	.061
86	.062	87	.063	88	.063	89	.064	90	.065
91	.066	92	.066	93	.067	94	.068	95	.069
96	.069	97	.070	98	.071	99	.071	100	.072
101	.073	102	.074	103	.074	104	.075	105	.076
106	.077	107	.077	108	.078	109	.079	110	.079
111	.080	112	.081	113	.082	114	.082	115	.083
116	.084	117	.085	118	.085	119	.086	120	.087
121	.088	122	.088	123	.089	124	.090	125	.090
126	.091	127	.092	128	.093	129	.093	130	.094
131	.095	132	.096	133	.096	134	.097	135	.098
136	.098	137	.099	138	.100	139	.101	140	.101
141	.102	142	.103	143	.104	144	.104	145	.105
146	.106	147	.106	148	.107	149	.108	150	.109
151	.109	152	.110	153	.111	154	.112	155	.112
156	.113	157	.114	158	.115	159	.115	160	.116
161	.117	162	.117	163	.118	164	.119	165	.120
166	.120	167	.121	168	.122	169	.123	170	.123
171	.124	172	.125	173	.125	174	.126	175	.127
176	.128	177	.128	178	.129	179	.130	180	.131
181	.131								

80 100

INITIAL SHORELINE (INCL. NOURISHMENT) POSITION

1	0.	.00	2	500.	.00
3	1000.	.00	4	1500.	.00
5	2000.	.00	6	2500.	.00
7	3000.	.00	8	3500.	.00
9	4000.	.00	10	4500.	.00
11	5000.	.00	12	5500.	.00
13	6000.	.00	14	6500.	.00
15	7000.	.00	16	7500.	.00
17	8000.	.00	18	8500.	.00
19	9000.	.00	20	9500.	.00
21	10000.	.00	22	10500.	.00
23	11000.	.00	24	11500.	.00
25	12000.	.00	26	12500.	.00
27	13000.	.00	28	13500.	.00
29	14000.	.00	30	14500.	.00
31	15000.	.00	32	15500.	.00
33	16000.	.00	34	16500.	.00
35	17000.	.00	36	17500.	.00
37	18000.	.00	38	18500.	.00
39	19000.	.00	40	19500.	.00
41	20000.	.00	42	20500.	.00
43	21000.	.00	44	21500.	.00
45	22000.	.00	46	22500.	.00
47	23000.	.00	48	23500.	.00
49	24000.	.00	50	24500.	.00
51	25000.	.00	52	25500.	.00
53	26000.	.00	54	26500.	.00
55	27000.	.00	56	27500.	.00
57	28000.	.00	58	28500.	.00
59	29000.	.00	60	29500.	.00
61	30000.	.00	62	30500.	.00
63	31000.	.00	64	31500.	.00
65	32000.	.00	66	32500.	.00
67	33000.	.00	68	33500.	.00
69	34000.	.00	70	34500.	.00
71	35000.	.00	72	35500.	.00
73	36000.	.00	74	36500.	.00
75	37000.	.00	76	37500.	.00
77	38000.	.00	78	38500.	.00
79	39000.	.00	80	39500.	112.00
81	40000.	112.00	82	40500.	112.00
83	41000.	112.00	84	41500.	112.00
85	42000.	112.00	86	42500.	112.00
87	43000.	112.00	88	43500.	112.00
89	44000.	112.00	90	44500.	112.00
91	45000.	112.00	92	45500.	112.00
93	46000.	112.00	94	46500.	112.00
95	47000.	112.00	96	47500.	112.00
97	48000.	112.00	98	48500.	112.00
99	49000.	112.00	100	49500.	112.00
101	50000.	.00	102	50500.	.00
103	51000.	.00	104	51500.	.00
105	52000.	.00	106	52500.	.00
107	53000.	.00	108	53500.	.00
109	54000.	.00	110	54500.	.00
111	55000.	.00	112	55500.	.00
113	56000.	.00	114	56500.	.00
115	57000.	.00	116	57500.	.00
117	58000.	.00	118	[illegible]	.00
119	59000.	.00	120	[illegible]	.00
121	60000.	.00	122	[illegible]	.00
123	61000.	.00	124	[illegible]	.00
125	62000.	.00	126	62500.	.00
127	63000.	.00	128	63500.	.00

```
   129     64000.        .00   130     64500.        .00
   131     65000.        .00   132     65500.        .00
   133     66000.        .00   134     66500.        .00
   135     67000.        .00   136     67500.        .00
   137     68000.        .00   138     68500.        .00
   139     69000.        .00   140     69500.        .00
   141     70000.        .00   142     70500.        .00
   143     71000.        .00   144     71500.        .00
   145     72000.        .00   146     72500.        .00
   147     73000.        .00   148     73500.        .00
   149     74000.        .00   150     74500.        .00
   151     75000.        .00   152     75500.        .00
   153     76000.        .00   154     76500.        .00
   155     77000.        .00   156     77500.        .00
   157     78000.        .00   158     78500.        .00
   159     79000.        .00   160     79500.        .00
   161     80000.        .00   162     80500.        .00
   163     81000.        .00   164     81500.        .00
   165     82000.        .00   166     82500.        .00
   167     83000.        .00   168     83500.        .00
   169     84000.        .00   170     84500.        .00
   171     85000.        .00   172     85500.        .00
   173     86000.        .00   174     86500.        .00
   175     87000.        .00   176     87500.        .00
   177     88000.        .00   178     88500.        .00
   179     89000.        .00   180     89500.        .00
   100    116     .000     .084     .000    -.542    -.542      .084     .000
                             TIME =          1  YEARS
   1    -2.00    2    -2.00    3    -2.00    4    -2.00    5    -2.00    6    -2.00
   7    -2.00    8    -2.00    9    -2.00   10    -2.00   11    -2.00   12    -2.00
  13    -2.00   14    -2.00   15    -2.00   16    -2.00   17    -2.00   18    -2.00
  19    -2.00   20    -2.00   21    -2.00   22    -2.00   23    -2.00   24    -2.00
  25    -2.00   26    -2.00   27    -2.00   28    -2.00   29    -2.00   30    -2.00
  31    -2.00   32    -2.00   33    -2.00   34    -2.00   35    -2.00   36    -2.00
  37    -2.00   38    -2.00   39    -2.00   40    -2.00   41    -2.00   42    -2.00
  43    -2.00   44    -2.00   45    -2.00   46    -2.00   47    -2.00   48    -2.00
  49    -2.00   50    -2.00   51    -2.00   52    -2.00   53    -2.00   54    -2.00
  55    -2.00   56    -2.00   57    -2.00   58    -2.00   59    -1.99   60    -1.98
  61    -1.96   62    -1.93   63    -1.87   64    -1.77   65    -1.60   66    -1.31
  67     -.87   68     -.18   69      .84   70     2.31   71     4.34   72     7.07
  73    10.62   74    15.06   75    20.45   76    26.75   77    33.87   78    41.64
  79    49.83   80    58.16   81    66.34   82    74.10   83    81.19   84    87.43
  85    92.71   86    96.98   87   100.24   88   102.52   89   103.87   90   104.31
  91   103.87   92   102.52   93   100.24   94    96.98   95    92.71   96    87.43
  97    81.19   98    74.10   99    66.34  100    58.16  101    49.83  102    41.64
 103    33.87  104    26.75  105    20.45  106    15.06  107    10.62  108     7.07
 109     4.34  110     2.31  111      .84  112     -.18  113     -.87  114    -1.31
 115    -1.60  116    -1.77  117    -1.87  118    -1.93  119    -1.96  120    -1.98
 121    -1.99  122    -2.00  123    -2.00  124    -2.00  125    -2.00  126    -2.00
 127    -2.00  128    -2.00  129    -2.00  130    -2.00  131    -2.00  132    -2.00
 133    -2.00  134    -2.00  135    -2.00  136    -2.00  137    -2.00  138    -2.00
 139    -2.00  140    -2.00  141    -2.00  142    -2.00  143    -2.00  144    -2.00
 145    -2.00  146    -2.00  147    -2.00  148    -2.00  149    -2.00  150    -2.00
 151    -2.00  152    -2.00  153    -2.00  154    -2.00  155    -2.00  156    -2.00
 157    -2.00  158    -2.00  159    -2.00  160    -2.00  161    -2.00  162    -2.00
 163    -2.00  164    -2.00  165    -2.00  166    -2.00  167    -2.00  168    -2.00
 169    -2.00  170    -2.00  171    -2.00  172    -2.00  173    -2.00  174    -2.00
 175    -2.00  176    -2.00  177    -2.00  178    -2.00  179    -2.00  180    -2.00
      LCUR =        1  PCT(LCUR) =         .78
      LCUR =        2  PCT(LCUR) =    81   .68
      LCUR =        3  PCT(LCUR) =         .60
      LCUR =        4  PCT(LCUR) =         .53
                             TIME =          5  YEARS
   1   -10.00    2   -10.00    3   -10.00    4   -10.00    5   -10.00    6   -10.00
   7   -10.00    8   -10.00    9   -10.00   10   -10.00   11   -10.00   12   -10.00
  13   -10.00   14   -10.00   15   -10.00   16   -10.00   17   -10.00   18   -10.00
```

19	-10.00	20	-10.00	21	-10.00	22	-10.00	23	-10.00	24	-10.00
25	-10.00	26	-10.00	27	-10.00	28	-10.00	29	-10.00	30	-10.00
31	-10.00	32	-10.00	33	-9.99	34	-9.99	35	-9.99	36	-9.98
37	-9.98	38	-9.97	39	-9.96	40	-9.94	41	-9.92	42	-9.90
43	-9.86	44	-9.82	45	-9.77	46	-9.70	47	-9.61	48	-9.50
49	-9.37	50	-9.21	51	-9.00	52	-8.76	53	-8.46	54	-8.10
55	-7.68	56	-7.17	57	-6.58	58	-5.89	59	-5.09	60	-4.17
61	-3.12	62	-1.93	63	-.59	64	.91	65	2.57	66	4.40
67	6.41	68	8.58	69	10.91	70	13.41	71	16.05	72	18.82
73	21.71	74	24.70	75	27.75	76	30.84	77	33.93	78	37.00
79	40.01	80	42.92	81	45.69	82	48.29	83	50.69	84	52.84
85	54.71	86	56.29	87	57.54	88	58.45	89	59.00	90	59.18
91	59.00	92	58.45	93	57.54	94	56.29	95	54.71	96	52.84
97	50.69	98	48.29	99	45.69	100	42.92	101	40.01	102	37.00
103	33.93	104	30.84	105	27.75	106	24.70	107	21.71	108	18.82
109	16.05	110	13.41	111	10.91	112	8.58	113	6.41	114	4.40
115	2.57	116	.91	117	-.59	118	-1.93	119	-3.12	120	-4.17
121	-5.09	122	-5.89	123	-6.58	124	-7.17	125	-7.68	126	-8.10
127	-8.46	128	-8.76	129	-9.00	130	-9.21	131	-9.37	132	-9.50
133	-9.61	134	-9.70	135	-9.77	136	-9.82	137	-9.86	138	-9.90
139	-9.92	140	-9.94	141	-9.96	142	-9.97	143	-9.98	144	-9.98
145	-9.99	146	-9.99	147	-9.99	148	-10.00	149	-10.00	150	-10.00
151	-10.00	152	-10.00	153	-10.00	154	-10.00	155	-10.00	156	-10.00
157	-10.00	158	-10.00	159	-10.00	160	-10.00	161	-10.00	162	-10.00
163	-10.00	164	-10.00	165	-10.00	166	-10.00	167	-10.00	168	-10.00
169	-10.00	170	-10.00	171	-10.00	172	-10.00	173	-10.00	174	-10.00
175	-10.00	176	-10.00	177	-10.00	178	-10.00	179	-10.00	180	-10.00

LCUR = 5 PCT(LCUR) = .47
LCUR = 6 PCT(LCUR) = .42
LCUR = 7 PCT(LCUR) = .38
LCUR = 8 PCT(LCUR) = .33
LCUR = 9 PCT(LCUR) = .30

TIME = 10 YEARS

1	-20.00	2	-20.00	3	-20.00	4	-20.00	5	-20.00	6	-20.00
7	-20.00	8	-20.00	9	-20.00	10	-20.00	11	-20.00	12	-20.00
13	-19.99	14	-19.99	15	-19.99	16	-19.99	17	-19.99	18	-19.98
19	-19.98	20	-19.97	21	-19.97	22	-19.96	23	-19.95	24	-19.94
25	-19.92	26	-19.91	27	-19.89	28	-19.86	29	-19.83	30	-19.80
31	-19.76	32	-19.71	33	-19.65	34	-19.59	35	-19.51	36	-19.42
37	-19.31	38	-19.19	39	-19.05	40	-18.89	41	-18.70	42	-18.49
43	-18.25	44	-17.98	45	-17.68	46	-17.34	47	-16.96	48	-16.53
49	-16.05	50	-15.53	51	-14.95	52	-14.32	53	-13.62	54	-12.86
55	-12.04	56	-11.15	57	-10.19	58	-9.16	59	-8.06	60	-6.88
61	-5.64	62	-4.33	63	-2.96	64	-1.51	65	-.01	66	1.54
67	3.15	68	4.80	69	6.48	70	8.19	71	9.92	72	11.66
73	13.40	74	15.12	75	16.82	76	18.48	77	20.10	78	21.66
79	23.14	80	24.55	81	25.85	82	27.06	83	28.14	84	29.10
85	29.93	86	30.62	87	31.16	88	31.55	89	31.79	90	31.87
91	31.79	92	31.55	93	31.16	94	30.62	95	29.93	96	29.10
97	28.14	98	27.06	99	25.85	100	24.55	101	23.14	102	21.66
103	20.10	104	18.48	105	16.82	106	15.12	107	13.40	108	11.66
109	9.92	110	8.19	111	6.48	112	4.80	113	3.15	114	1.54
115	-.01	116	-1.51	117	-2.95	118	-4.33	119	-5.64	120	-6.88
121	-8.06	122	-9.16	123	-10.19	124	-11.15	125	-12.04	126	-12.86
127	-13.62	128	-14.31	129	-14.95	130	-15.53	131	-16.05	132	-16.53
133	-16.96	134	-17.34	135	-17.68	136	-17.98	137	-18.25	138	-18.49
139	-18.70	140	-18.89	141	-19.05	142	-19.19	143	-19.31	144	-19.42
145	-19.51	146	-19.59	147	-19.65	148	-19.71	149	-19.76	150	-19.80
151	-19.83	152	-19.86	153	-19.89	154	-19.91	155	-19.92	156	-19.94
157	-19.95	158	-19.96	159	-19.97	160	-19.97	161	-19.98	162	-19.98
163	-19.99	164	-19.99	165	-19.9	[illegible]	-19.99	167	-19.99	168	-20.00
169	-20.00	170	-20.00	171	-20.0	[illegible]	-20.00	173	-20.00	174	-20.00
175	-20.00	176	-20.00	177	-20.0	[illegible]	-20.00	179	-20.00	180	-20.00

LCUR = 10 PCT(LCUR) = .26
LCUR = 11 PCT(LCUR) = .23
LCUR = 12 PCT(LCUR) = .19

```
LCUR =      13  PCT(LCUR) =       .16
LCUR =      14  PCT(LCUR) =       .13
LCUR =      15  PCT(LCUR) =       .10
LCUR =      16  PCT(LCUR) =       .08
LCUR =      17  PCT(LCUR) =       .05
LCUR =      18  PCT(LCUR) =       .02
LCUR =      19  PCT(LCUR) =       .00
LCUR =      20  PCT(LCUR) =      -.03
LCUR =      21  PCT(LCUR) =      -.05
LCUR =      22  PCT(LCUR) =      -.08
LCUR =      23  PCT(LCUR) =      -.10
LCUR =      24  PCT(LCUR) =      -.13
LCUR =      25  PCT(LCUR) =      -.15
LCUR =      26  PCT(LCUR) =      -.17
LCUR =      27  PCT(LCUR) =      -.20
LCUR =      28  PCT(LCUR) =      -.22
LCUR =      29  PCT(LCUR) =      -.24
                TIME =       30  YEARS
  1  -59.99   2  -59.92   3  -59.84   4  -59.76   5  -59.68   6  -59.60
  7  -59.52   8  -59.43   9  -59.34  10  -59.24  11  -59.14  12  -59.04
 13  -58.93  14  -58.82  15  -58.69  16  -58.56  17  -58.43  18  -58.28
 19  -58.13  20  -57.97  21  -57.80  22  -57.62  23  -57.42  24  -57.22
 25  -57.01  26  -56.78  27  -56.54  28  -56.29  29  -56.02  30  -55.75
 31  -55.45  32  -55.15  33  -54.83  34  -54.49  35  -54.14  36  -53.78
 37  -53.40  38  -53.00  39  -52.59  40  -52.17  41  -51.72  42  -51.27
 43  -50.80  44  -50.31  45  -49.81  46  -49.30  47  -48.77  48  -48.23
 49  -47.68  50  -47.11  51  -46.54  52  -45.95  53  -45.36  54  -44.76
 55  -44.15  56  -43.53  57  -42.91  58  -42.28  59  -41.66  60  -41.03
 61  -40.40  62  -39.77  63  -39.15  64  -38.53  65  -37.92  66  -37.31
 67  -36.71  68  -36.13  69  -35.55  70  -34.99  71  -34.45  72  -33.92
 73  -33.41  74  -32.92  75  -32.46  76  -32.01  77  -31.59  78  -31.19
 79  -30.83  80  -30.49  81  -30.17  82  -29.89  83  -29.64  84  -29.42
 85  -29.24  86  -29.08  87  -28.97  88  -28.88  89  -28.83  90  -28.81
 91  -28.83  92  -28.88  93  -28.97  94  -29.08  95  -29.24  96  -29.42
 97  -29.64  98  -29.89  99  -30.17 100  -30.49 101  -30.83 102  -31.19
103  -31.59 104  -32.01 105  -32.45 106  -32.92 107  -33.41 108  -33.92
109  -34.45 110  -34.99 111  -35.55 112  -36.13 113  -36.71 114  -37.31
115  -37.92 116  -38.53 117  -39.15 118  -39.77 119  -40.40 120  -41.03
121  -41.66 122  -42.28 123  -42.91 124  -43.53 125  -44.15 126  -44.76
127  -45.36 128  -45.95 129  -46.54 130  -47.11 131  -47.68 132  -48.23
133  -48.77 134  -49.30 135  -49.81 136  -50.31 137  -50.80 138  -51.27
139  -51.72 140  -52.16 141  -52.59 142  -53.00 143  -53.40 144  -53.78
145  -54.14 146  -54.49 147  -54.83 148  -55.15 149  -55.45 150  -55.74
151  -56.02 152  -56.28 153  -56.54 154  -56.77 155  -57.00 156  -57.21
157  -57.42 158  -57.61 159  -57.79 160  -57.96 161  -58.12 162  -58.27
163  -58.41 164  -58.55 165  -58.68 166  -58.80 167  -58.91 168  -59.02
169  -59.12 170  -59.21 171  -59.31 172  -59.39 173  -59.48 174  -59.56
175  -59.63 176  -59.71 177  -59.78 178  -59.85 179  -59.92 180  -59.99
LCUR =      30  PCT(LCUR) =      -.26
```

APPENDIX C

NUMERICAL EXAMPLE 1

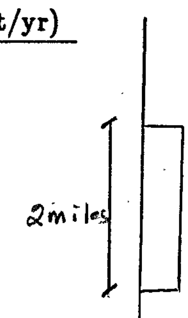
BEACH NOURISHMENT PROJECTION
(Numerical Procedure)

General Location: Example 1

Wave Height, H_0 (Fig. 22):	2.0 ft.,	Closure Depth, h_* (Fig. 8):	17 ft.
Wave Period, T (Fig. 23):	6.0 sec.,	Berm Height, B:	6 ft.
Wave Direction, α_0:	90 °,	Sand Diameter, D:	0.35 mm
Deep Water Contour Orientation, β_0:	90 °,	Transport Factor, K (Fig. 5):	0.77
Longshore Axis Orientation, μ:	180 °,	VFACT:	1.0
Grid Dimension, Δx:	500 ft	Background Transport, QREF:	0.0 ft^3/s
Time Increment, Δt:	86400 sec	IREF:	1
		IMAX:	180
		NTIMES:	10950
		No. of Structures, NS:	0

Structure Specificiation / **Background Erosion**

Structure Number	Structure Location, I	Structure Length (ft)	x (ft.)	Erosion Rate, ER, (ft/yr)
1	–	–	0.0	0.0
2			90,000	0.0
3				
4				
5				
6				



No Background Erosion

Equilibrated Beach Width Δy_0

A_N (Fig. 7) or From Profile:	____ ft$^{1/3}$
A_F (Fig. 7):	____ ft$^{1/3}$
Volume Per Unit Length:	____ ft^3/ft
Δy_0 (Figs. 11 and 12):	112 ft

Nourishment Specification

I Range			Δy_0
80	to	100	112 ft
	to		
	to		
	to		
	to		

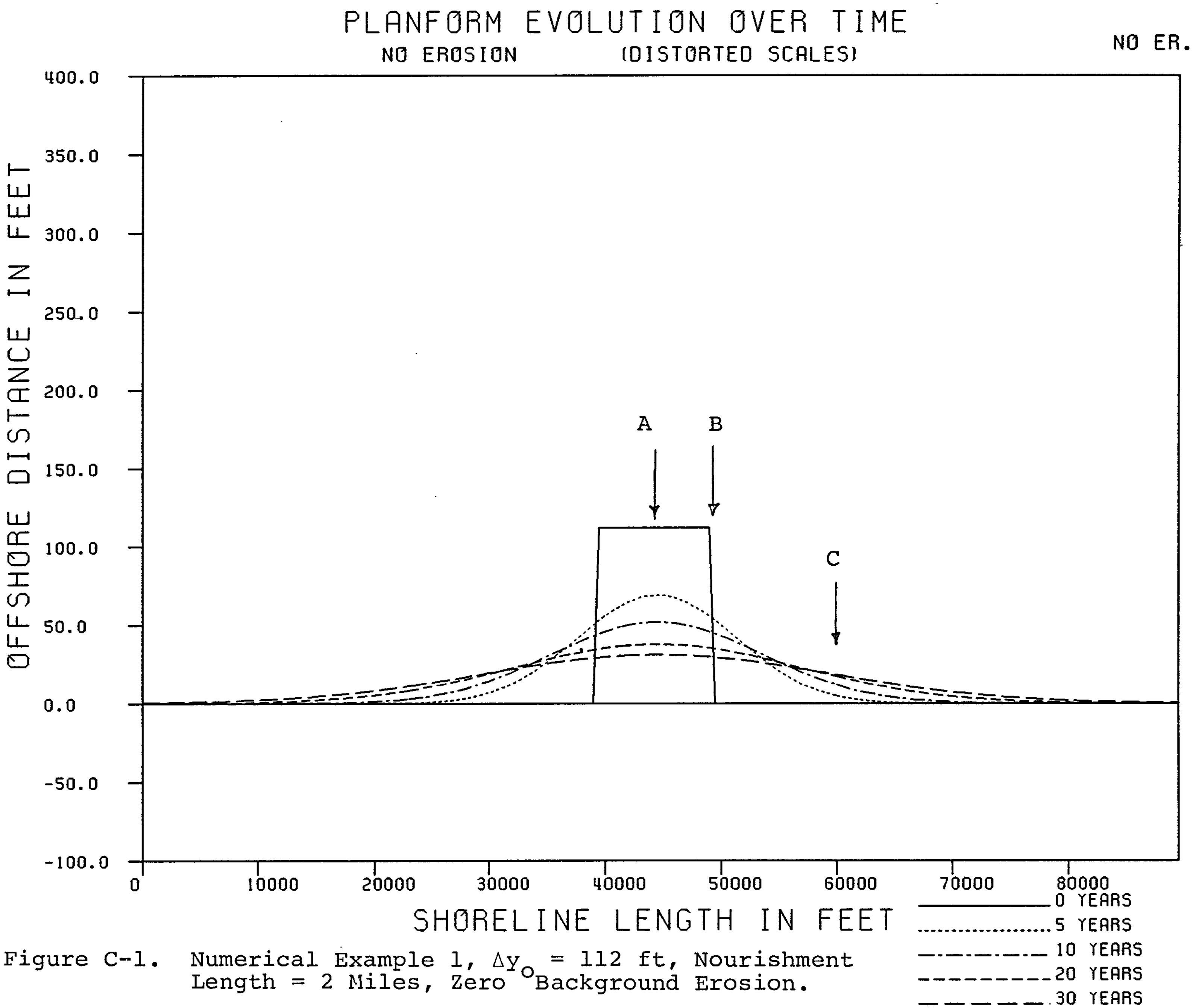


Figure C-1. Numerical Example 1, Δy_o = 112 ft, Nourishment Length = 2 Miles, Zero Background Erosion.

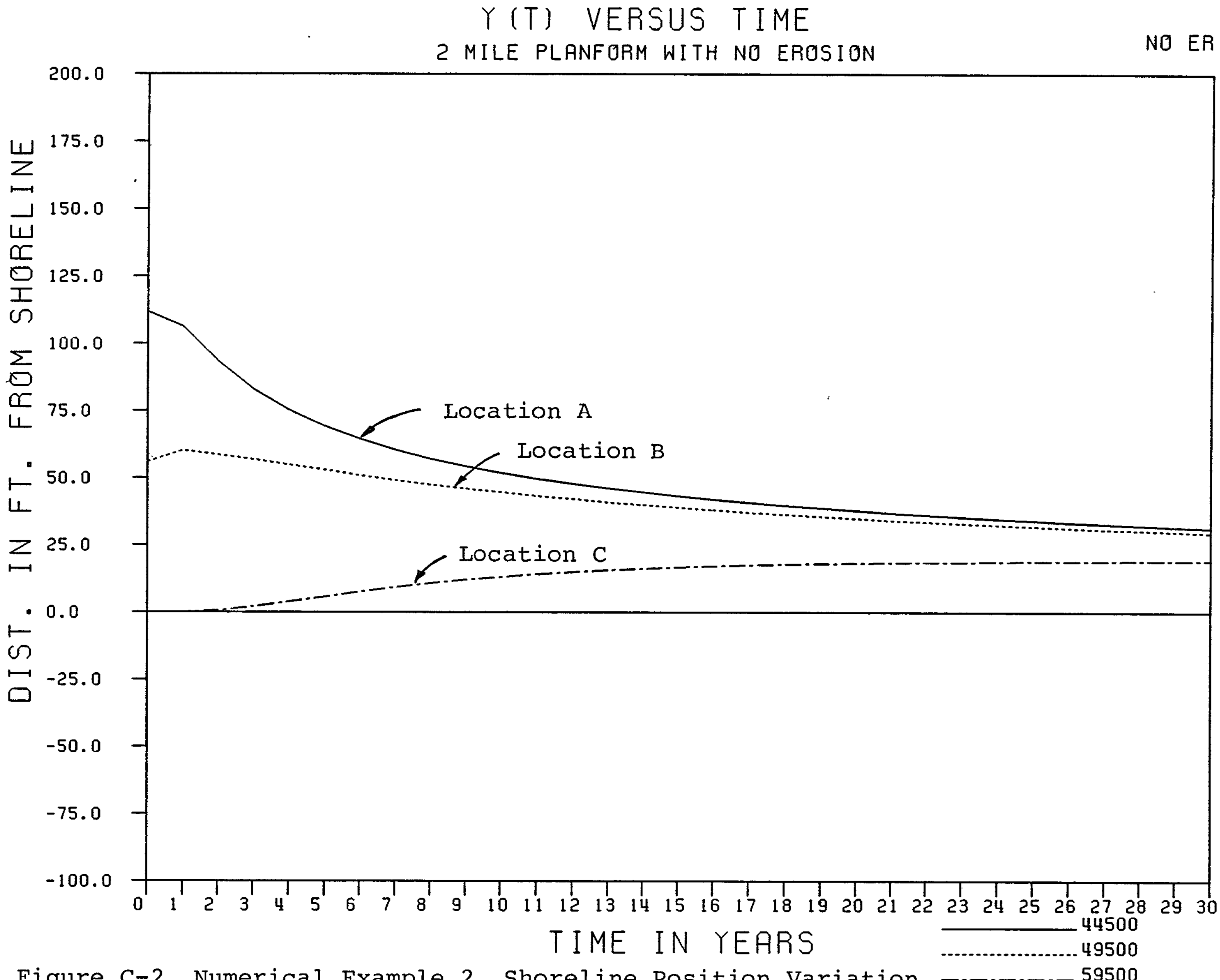


Figure C-2. Numerical Example 2, Shoreline Position Variation with Time at Locations Indicated and Shown in Figure C-1.

INPUT FILE: DNRBS.INP
(Example No. 1)

```
  EXAMPLE NO. 1 NO BACK. EROS. NO STRUC. 2 MILE PROJ.
  2.00      6.0     90.0    90.0    180.0    500.0 86400.0
  17.0      6.0     0.77     1.0      0.0      1    180 10950      0
   0.0      0.0   90000.     0.0   49500.     2.0   60000.     3.0
90000.      3.0 100000.      3.0 140000.      2.0
  80   100
  80   112.0
  81   112.0
  82   112.0
  83   112.0
  84   112.0
  85   112.0
  86   112.0
  87   112.0
  88   112.0
  89   112.0
  90   112.0
  91   112.0
  92   112.0
  93   112.0
  94   112.0
  95   112.0
  96   112.0
  97   112.0
  98   112.0
  99   112.0
 100   112.0
```

OUTPUT FILE: DNRBS.OUT
(Example No. 1)

EXAMPLE NO. 1 NO BACK. EROS. NO STRUC. 2 MILE PROJ.

```
 HO =   2.00 FT., T =   6.00 SEC.,  ALPO =  90.00 DEG., BTAO =  90.00 DEG.,
XMU =  180.00 DEG., DX =   500.00 FT., DT = 86400.00 SEC.
 HSTR =    17.00 FT., B =      6.00 FT., XK =       .77 VFACT =      1.00
    QBKREF =       .00 FT.**3/SEC.
   IREF =       1, IMAX =     180, NTIMES =    10950, NS =        0



 .00E+00      .00 .90E+05      .00 .50E+05    2.00 .60E+05    3.00
 .90E+05     3.00 .10E+06     3.00 .14E+06    2.00
```

BACKGROUND EROSION TRANSPORT RATES

1	.000	2	.000	3	.000	4	.000	5	.000
6	.000	7	.000	8	.000	9	.000	10	.000
11	.000	12	.000	13	.000	14	.000	15	.000
16	.000	17	.000	18	.000	19	.000	20	.000
21	.000	22	.000	23	.000	24	.000	25	.000
26	.000	27	.000	28	.000	29	.000	30	.000
31	.000	32	.000	33	.000	34	.000	35	.000
36	.000	37	.000	38	.000	39	.000	40	.000
41	.000	42	.000	43	.000	44	.000	45	.000
46	.000	47	.000	48	.000	49	.000	50	.000
51	.000	52	.000	53	.000	54	.000	55	.000
56	.000	57	.000	58	.000	59	.000	60	.000
61	.000	62	.000	63	.000	64	.000	65	.000
66	.000	67	.000	68	.000	69	.000	70	.000
71	.000	72	.000	73	.000	74	.000	75	.000
76	.000	77	.000	78	.000	79	.000	80	.000
81	.000	82	.000	83	.000	84	.000	85	.000
86	.000	87	.000	88	.000	89	.000	90	.000
91	.000	92	.000	93	.000	94	.000	95	.000
96	.000	97	.000	98	.000	99	.000	100	.000
101	.000	102	.000	103	.000	104	.000	105	.000
106	.000	107	.000	108	.000	109	.000	110	.000
111	.000	112	.000	113	.000	114	.000	115	.000
116	.000	117	.000	118	.000	119	.000	120	.000
121	.000	122	.000	123	.000	124	.000	125	.000
126	.000	127	.000	128	.000	129	.000	130	.000
131	.000	132	.000	133	.000	134	.000	135	.000
136	.000	137	.000	138	.000	139	.000	140	.000
141	.000	142	.000	143	[illegible]	144	.000	145	.000
146	.000	147	.000	148	[illegible]	149	.000	150	.000
151	.000	152	.000	153	[illegible]	154	.000	155	.000
156	.000	157	.000	158	.000	159	.000	160	.000
161	.000	162	.000	163	.000	164	.000	165	.000
166	.000	167	.000	168	.000	169	.000	170	.000

171	.000	172	.000	173	.000	174	.000	175	.000
176	.000	177	.000	178	.000	179	.000	180	.000
181	.000								

80 100

INITIAL SHORELINE (INCL. NOURISHMENT) POSITION

1	0.	.00	2	500.	.00
3	1000.	.00	4	1500.	.00
5	2000.	.00	6	2500.	.00
7	3000.	.00	8	3500.	.00
9	4000.	.00	10	4500.	.00
11	5000.	.00	12	5500.	.00
13	6000.	.00	14	6500.	.00
15	7000.	.00	16	7500.	.00
17	8000.	.00	18	8500.	.00
19	9000.	.00	20	9500.	.00
21	10000.	.00	22	10500.	.00
23	11000.	.00	24	11500.	.00
25	12000.	.00	26	12500.	.00
27	13000.	.00	28	13500.	.00
29	14000.	.00	30	14500.	.00
31	15000.	.00	32	15500.	.00
33	16000.	.00	34	16500.	.00
35	17000.	.00	36	17500.	.00
37	18000.	.00	38	18500.	.00
39	19000.	.00	40	19500.	.00
41	20000.	.00	42	20500.	.00
43	21000.	.00	44	21500.	.00
45	22000.	.00	46	22500.	.00
47	23000.	.00	48	23500.	.00
49	24000.	.00	50	24500.	.00
51	25000.	.00	52	25500.	.00
53	26000.	.00	54	26500.	.00
55	27000.	.00	56	27500.	.00
57	28000.	.00	58	28500.	.00
59	29000.	.00	60	29500.	.00
61	30000.	.00	62	30500.	.00
63	31000.	.00	64	31500.	.00
65	32000.	.00	66	32500.	.00
67	33000.	.00	68	33500.	.00
69	34000.	.00	70	34500.	.00
71	35000.	.00	72	35500.	.00
73	36000.	.00	74	36500.	.00
75	37000.	.00	76	37500.	.00
77	38000.	.00	78	38500.	.00
79	39000.	.00	80	39500.	112.00
81	40000.	112.00	82	40500.	112.00
83	41000.	112.00	84	41500.	112.00
85	42000.	112.00	86	42500.	112.00
87	43000.	112.00	88	43500.	112.00
89	44000.	112.00	90	44500.	112.00
91	45000.	112.00	92	45500.	112.00
93	46000.	112.00	94	46500.	112.00
95	47000.	112.00	96	47500.	112.00
97	48000.	112.00	98	48500.	112.00
99	49000.	112.00	100	49500.	112.00
101	50000.	.00	102	50500.	.00
103	51000.	.00	104	51500.	.00
105	52000.	.00	106	5250	.00
107	53000.	.00	108	5350	.00
109	54000.	.00	110	545C	.00
111	55000.	.00	112	55500.	.00
113	56000.	.00	114	56500.	.00
115	57000.	.00	116	57500.	.00

117	58000.	.00	118	58500.	.00
119	59000.	.00	120	59500.	.00
121	60000.	.00	122	60500.	.00
123	61000.	.00	124	61500.	.00
125	62000.	.00	126	62500.	.00
127	63000.	.00	128	63500.	.00
129	64000.	.00	130	64500.	.00
131	65000.	.00	132	65500.	.00
133	66000.	.00	134	66500.	.00
135	67000.	.00	136	67500.	.00
137	68000.	.00	138	68500.	.00
139	69000.	.00	140	69500.	.00
141	70000.	.00	142	70500.	.00
143	71000.	.00	144	71500.	.00
145	72000.	.00	146	72500.	.00
147	73000.	.00	148	73500.	.00
149	74000.	.00	150	74500.	.00
151	75000.	.00	152	75500.	.00
153	76000.	.00	154	76500.	.00
155	77000.	.00	156	77500.	.00
157	78000.	.00	158	78500.	.00
159	79000.	.00	160	79500.	.00
161	80000.	.00	162	80500.	.00
163	81000.	.00	164	81500.	.00
165	82000.	.00	166	82500.	.00
167	83000.	.00	168	83500.	.00
169	84000.	.00	170	84500.	.00
171	85000.	.00	172	85500.	.00
173	86000.	.00	174	86500.	.00
175	87000.	.00	176	87500.	.00
177	88000.	.00	178	88500.	.00
179	89000.	.00	180	89500.	.00

100 116 .000 .000 .000 .000 .000 .000 .000

TIME = 1 YEARS

1	.00	2	.00	3	.00	4	.00	5	.00	6	.00
7	.00	8	.00	9	.00	10	.00	11	.00	12	.00
13	.00	14	.00	15	.00	16	.00	17	.00	18	.00
19	.00	20	.00	21	.00	22	.00	23	.00	24	.00
25	.00	26	.00	27	.00	28	.00	29	.00	30	.00
31	.00	32	.00	33	.00	34	.00	35	.00	36	.00
37	.00	38	.00	39	.00	40	.00	41	.00	42	.00
43	.00	44	.00	45	.00	46	.00	47	.00	48	.00
49	.00	50	.00	51	.00	52	.00	53	.00	54	.00
55	.00	56	.00	57	.00	58	.00	59	.01	60	.02
61	.04	62	.07	63	.13	64	.23	65	.40	66	.69
67	1.13	68	1.82	69	2.84	70	4.31	71	6.34	72	9.07
73	12.62	74	17.06	75	22.45	76	28.75	77	35.87	78	43.64
79	51.83	80	60.16	81	68.34	82	76.10	83	83.19	84	89.43
85	94.71	86	98.98	87	102.24	88	104.52	89	105.87	90	106.31
91	105.87	92	104.52	93	102.24	94	98.98	95	94.71	96	89.43
97	83.19	98	76.10	99	68.34	100	60.16	101	51.83	102	43.64
103	35.87	104	28.75	105	22.45	106	17.06	107	12.62	108	9.07
109	6.34	110	4.31	111	2.84	112	1.82	113	1.13	114	.69
115	.40	116	.23	117	.13	118	.07	119	.04	120	.02
121	.01	122	.00	123	.00	124	.00	125	.00	126	.00
127	.00	128	.00	129	.00	130	.00	131	.00	132	.00
133	.00	134	.00	135	.00	136	.00	137	.00	138	.00
139	.00	140	.00	141	.00	142	.00	143	.00	144	.00
145	.00	146	.00	147	.00	148	.00	149	.00	150	.00
151	.00	152	.00	153	.00	154	.00	155	.00	156	.00
157	.00	158	.00	159	.00	160	.00	161	.00	162	.00
163	.00	164	.00	165	.00	[illegible] 91	.00	167	.00	168	.00
169	.00	170	.00	171	.00	[illegible]	.00	173	.00	174	.00
175	.00	176	.00	177	.00	178	.00	179	.00	180	.00

LCUR = 1 PCT(LCUR) = .80

LCUR = 2 PCT(LCUR) = .71

LCUR = 3 PCT(LCUR) = .65
LCUR = 4 PCT(LCUR) = .60

TIME = 5 YEARS

1	.00	2	.00	3	.00	4	.00	5	.00	6	.00
7	.00	8	.00	9	.00	10	.00	11	.00	12	.00
13	.00	14	.00	15	.00	16	.00	17	.00	18	.00
19	.00	20	.00	21	.00	22	.00	23	.00	24	.00
25	.00	26	.00	27	.00	28	.00	29	.00	30	.00
31	.00	32	.00	33	.01	34	.01	35	.01	36	.02
37	.02	38	.03	39	.04	40	.06	41	.08	42	.10
43	.14	44	.18	45	.23	46	.30	47	.39	48	.50
49	.63	50	.79	51	1.00	52	1.24	53	1.54	54	1.90
55	2.32	56	2.83	57	3.42	58	4.11	59	4.91	60	5.83
61	6.88	62	8.07	63	9.41	64	10.91	65	12.57	66	14.40
67	16.41	68	18.58	69	20.91	70	23.41	71	26.05	72	28.82
73	31.71	74	34.70	75	37.75	76	40.84	77	43.93	78	47.00
79	50.01	80	52.92	81	55.69	82	58.29	83	60.69	84	62.84
85	64.71	86	66.29	87	67.54	88	68.45	89	69.00	90	69.18
91	69.00	92	68.45	93	67.54	94	66.29	95	64.71	96	62.84
97	60.69	98	58.29	99	55.69	100	52.92	101	50.01	102	47.00
103	43.93	104	40.84	105	37.75	106	34.70	107	31.71	108	28.82
109	26.05	110	23.41	111	20.91	112	18.58	113	16.41	114	14.40
115	12.57	116	10.91	117	9.41	118	8.07	119	6.88	120	5.83
121	4.91	122	4.11	123	3.42	124	2.83	125	2.32	126	1.90
127	1.54	128	1.24	129	1.00	130	.79	131	.63	132	.50
133	.39	134	.30	135	.23	136	.18	137	.14	138	.10
139	.08	140	.06	141	.04	142	.03	143	.02	144	.02
145	.01	146	.01	147	.01	148	.00	149	.00	150	.00
151	.00	152	.00	153	.00	154	.00	155	.00	156	.00
157	.00	158	.00	159	.00	160	.00	161	.00	162	.00
163	.00	164	.00	165	.00	166	.00	167	.00	168	.00
169	.00	170	.00	171	.00	172	.00	173	.00	174	.00
175	.00	176	.00	177	.00	178	.00	179	.00	180	.00

LCUR = 5 PCT(LCUR) = .56
LCUR = 6 PCT(LCUR) = .53
LCUR = 7 PCT(LCUR) = .50
LCUR = 8 PCT(LCUR) = .48
LCUR = 9 PCT(LCUR) = .46

TIME = 10 YEARS

1	.00	2	.00	3	.00	4	.00	5	.00	6	.00
7	.00	8	.00	9	.00	10	.00	11	.00	12	.00
13	.01	14	.01	15	.01	16	.01	17	.01	18	.02
19	.02	20	.03	21	.03	22	.04	23	.05	24	.06
25	.08	26	.09	27	.11	28	.14	29	.17	30	.20
31	.24	32	.29	33	.35	34	.41	35	.49	36	.58
37	.69	38	.81	39	.95	40	1.11	41	1.30	42	1.51
43	1.75	44	2.02	45	2.32	46	2.66	47	3.04	48	3.47
49	3.95	50	4.47	51	5.05	52	5.68	53	6.38	54	7.14
55	7.96	56	8.85	57	9.81	58	10.84	59	11.94	60	13.12
61	14.36	62	15.67	63	17.05	64	18.49	65	19.99	66	21.54
67	23.15	68	24.80	69	26.48	70	28.19	71	29.92	72	31.66
73	33.40	74	35.12	75	36.82	76	38.48	77	40.10	78	41.66
79	43.14	80	44.55	81	45.85	82	47.06	83	48.14	84	49.10
85	49.93	86	50.62	87	51.16	88	51.55	89	51.79	90	51.87
91	51.79	92	51.55	93	51.16	94	50.62	95	49.93	96	49.10
97	48.14	98	47.06	99	45.85	100	44.55	101	43.14	102	41.66
103	40.10	104	38.48	105	36.82	106	35.12	107	33.40	108	31.66
109	29.92	110	28.19	111	26.48	112	24.80	113	23.15	114	21.54
115	19.99	116	18.49	117	17.05	118	15.67	119	14.36	120	13.12
121	11.94	122	10.84	123	9.81	124	8.85	125	7.96	126	7.14
127	6.38	128	5.68	129	5.05	130	4.47	131	3.95	132	3.47
133	3.04	134	2.66	135	2.[illegible]	[illegible]	2.02	137	1.75	138	1.51
139	1.30	140	1.11	141	[illegible]	[illegible]	.81	143	.69	144	.58
145	.49	146	.41	147	[illegible]	148	.29	149	.24	150	.20
151	.17	152	.14	153	.11	154	.09	155	.08	156	.06
157	.05	158	.04	159	.03	160	.03	161	.02	162	.02

```
 163      .01 164      .01 165      .01 166      .01 167      .01 168      .00
 169      .00 170      .00 171      .00 172      .00 173      .00 174      .00
 175      .00 176      .00 177      .00 178      .00 179      .00 180      .00
     LCUR =      10  PCT(LCUR) =      .44
     LCUR =      11  PCT(LCUR) =      .42
     LCUR =      12  PCT(LCUR) =      .41
     LCUR =      13  PCT(LCUR) =      .39
     LCUR =      14  PCT(LCUR) =      .38
     LCUR =      15  PCT(LCUR) =      .37
     LCUR =      16  PCT(LCUR) =      .36
     LCUR =      17  PCT(LCUR) =      .35
     LCUR =      18  PCT(LCUR) =      .34
     LCUR =      19  PCT(LCUR) =      .34
     LCUR =      20  PCT(LCUR) =      .33
     LCUR =      21  PCT(LCUR) =      .32
     LCUR =      22  PCT(LCUR) =      .31
     LCUR =      23  PCT(LCUR) =      .31
     LCUR =      24  PCT(LCUR) =      .30
     LCUR =      25  PCT(LCUR) =      .30
     LCUR =      26  PCT(LCUR) =      .29
     LCUR =      27  PCT(LCUR) =      .29
     LCUR =      28  PCT(LCUR) =      .28
     LCUR =      29  PCT(LCUR) =      .28
                     TIME =       30  YEARS
   1      .00   2      .08   3      .15   4      .23   5      .31   6      .40
   7      .48   8      .57   9      .66  10      .75  11      .85  12      .96
  13     1.07  14     1.18  15     1.30  16     1.43  17     1.57  18     1.72
  19     1.87  20     2.03  21     2.20  22     2.38  23     2.58  24     2.78
  25     2.99  26     3.22  27     3.46  28     3.71  29     3.98  30     4.25
  31     4.55  32     4.85  33     5.17  34     5.51  35     5.86  36     6.22
  37     6.60  38     7.00  39     7.41  40     7.83  41     8.28  42     8.73
  43     9.20  44     9.69  45    10.19  46    10.70  47    11.23  48    11.77
  49    12.32  50    12.89  51    13.46  52    14.05  53    14.64  54    15.24
  55    15.85  56    16.47  57    17.09  58    17.72  59    18.34  60    18.97
  61    19.60  62    20.23  63    20.85  64    21.47  65    22.08  66    22.69
  67    23.29  68    23.87  69    24.45  70    25.01  71    25.55  72    26.08
  73    26.59  74    27.08  75    27.55  76    27.99  77    28.41  78    28.81
  79    29.17  80    29.51  81    29.83  82    30.11  83    30.36  84    30.58
  85    30.76  86    30.92  87    31.04  88    31.12  89    31.17  90    31.19
  91    31.17  92    31.12  93    31.04  94    30.92  95    30.76  96    30.58
  97    30.36  98    30.11  99    29.83 100    29.51 101    29.17 102    28.81
 103    28.41 104    27.99 105    27.55 106    27.08 107    26.59 108    26.08
 109    25.55 110    25.01 111    24.45 112    23.87 113    23.29 114    22.69
 115    22.08 116    21.47 117    20.85 118    20.23 119    19.60 120    18.97
 121    18.34 122    17.72 123    17.09 124    16.47 125    15.85 126    15.24
 127    14.64 128    14.05 129    13.46 130    12.89 131    12.32 132    11.77
 133    11.23 134    10.70 135    10.19 136     9.69 137     9.20 138     8.73
 139     8.28 140     7.84 141     7.41 142     7.00 143     6.60 144     6.22
 145     5.86 146     5.51 147     5.17 148     4.85 149     4.55 150     4.26
 151     3.98 152     3.72 153     3.46 154     3.23 155     3.00 156     2.79
 157     2.58 158     2.39 159     2.21 160     2.04 161     1.88 162     1.73
 163     1.59 164     1.45 165     1.32 166     1.20 167     1.09 168      .98
 169      .88 170      .78 171      .69 172      .60 173      .52 174      .44
 175      .36 176      .29 177      .21 178      .14 179      .07 180      .00
     LCUR =      30  PCT(LCUR) =      .27
```

APPENDIX D

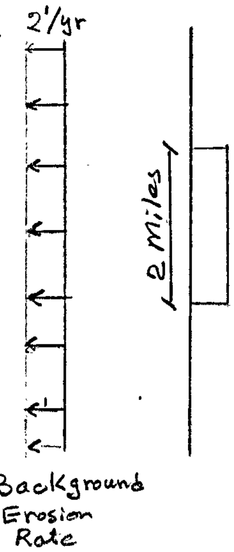
NUMERICAL EXAMPLE 2

BEACH NOURISHMENT PROJECTION
(Numerical Procedure)

General Location: Example 2

Wave Height, H_0 (Fig. 22):	2.0 ft.,	Closure Depth, h_* (Fig. 8):	17 ft.
Wave Period, T (Fig. 23):	6.0 sec.,	Berm Height, B:	6 ft.
Wave Direction, α_0:	90 °,	Sand Diameter, D:	0.35 mm
Deep Water Contour Orientation, β_0:	90 °,	Transport Factor, K (Fig. 5):	0.77
Longshore Axis Orientation, μ:	180 °,	VFACT:	1.0
Grid Dimension, Δx:	500 ft	Background Transport, QREF:	0 ft^3/s
Time Increment, Δt:	86,400 sec	IREF:	1
		IMAX:	180
		NTIMES:	10950
		No. of Structures, NS:	0

Structure Specificiation			Background Erosion	
Structure Number	Structure Location, I	Structure Length (ft)	x	Erosion Rate, ER, (ft/yr)
1			0.0	2.0
2			90000	2.0
3				
4				
5				
6				



Equilibrated Beach Width Δy_0

A_N (Fig. 7) or From Profile:	ft$^{1/3}$
A_F (Fig. 7):	ft$^{1/3}$
Volume Per Unit Length:	ft^3/ft
Δy_0 (Figs. 11 and 12):	112 ft

Nourishment Specification

I Range			Δy_0
80	to	100	112.0
	to		
	to		
	to		
	to		

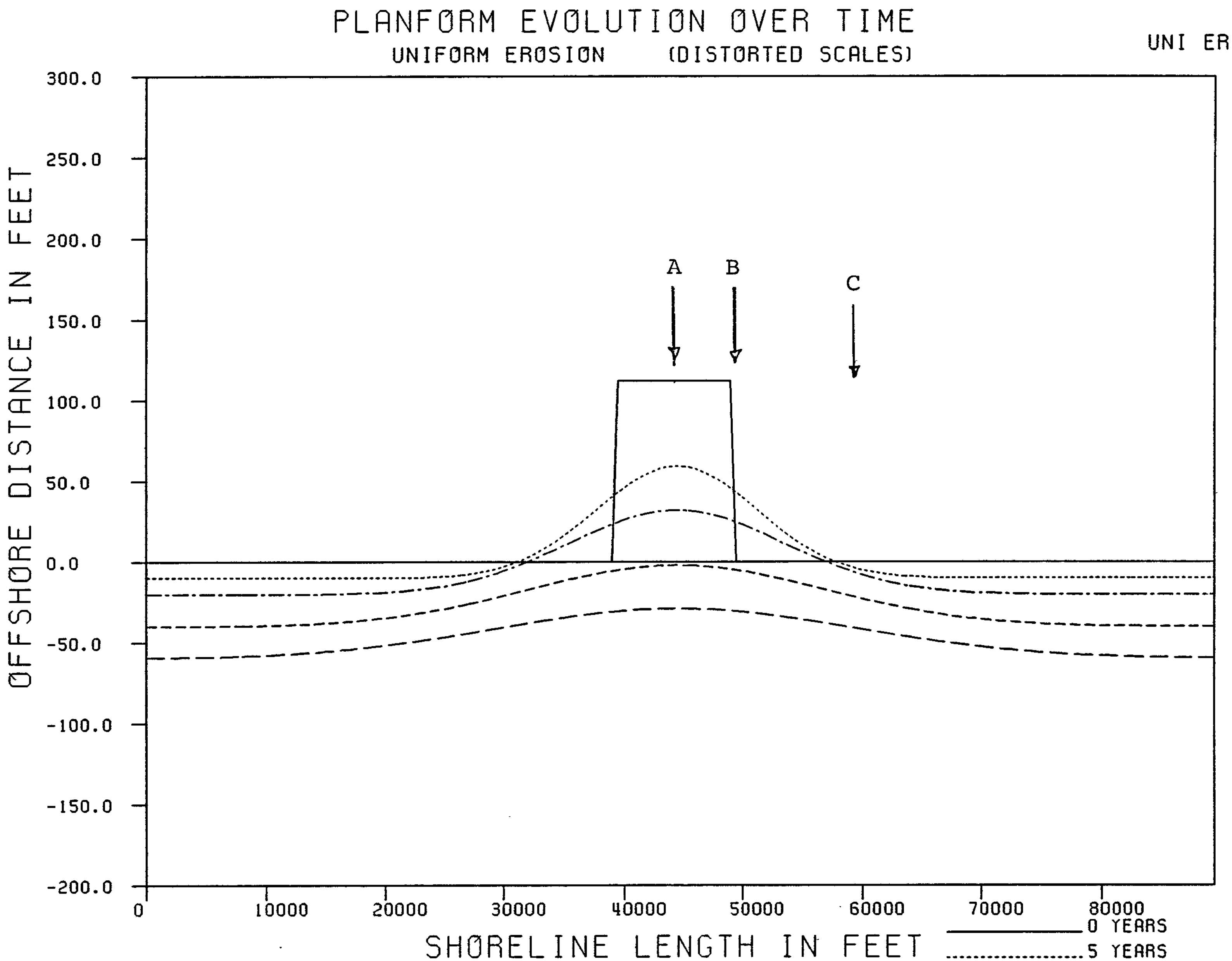


Figure D-1. Numerical Example 2, Δy_o = 112 ft, Nourishment Length = 2 Miles, Uniform Background Erosion = 2 ft/yr.

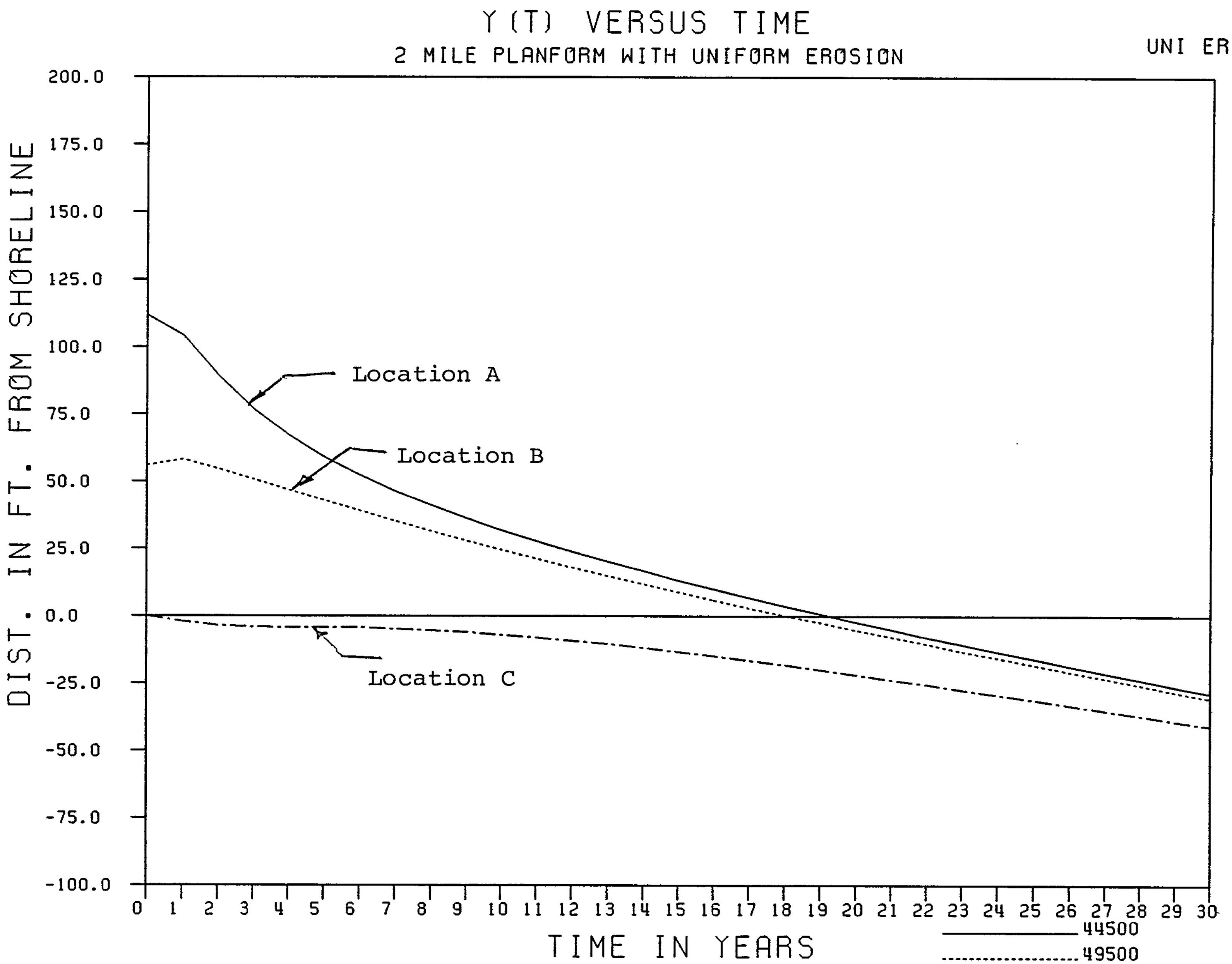


Figure D-2. Numerical Example 2, Shoreline Position Variation with Time at Locations Indicated and Shown in Figure D-1.

INPUT FILE: DNRBS.INP
(Example No. 2)

```
    EXAMPLE NO. 2 UNIF. BACK. EROS. NO STRUC. 2 MILE PROJ.
    2.00      6.0     90.0    90.0   180.0   500.0 86400.0
    17.0      6.0     0.77     1.0     0.0      1   180 10950      0
     0.0      2.0  90000.      2.0  49500.     2.0  60000.      3.0
  90000.      3.0 100000.      3.0 140000.     2.0
    80    100
    80    112.0
    81    112.0
    82    112.0
    83    112.0
    84    112.0
    85    112.0
    86    112.0
    87    112.0
    88    112.0
    89    112.0
    90    112.0
    91    112.0
    92    112.0
    93    112.0
    94    112.0
    95    112.0
    96    112.0
    97    112.0
    98    112.0
    99    112.0
   100    112.0
```

OUTPUT FILE: DNRBS.OUT
(Example No. 2)

EXAMPLE NO. 2 UNIF. BACK. EROS. NO STRUC. 2 MILE PROJ.

```
 HO =   2.00 FT., T =   6.00 SEC.,  ALPO =  90.00 DEG., BTAO =  90.00 DEG.,
XMU =  180.00 DEG., DX =   500.00 FT., DT = 86400.00 SEC.
 HSTR =    17.00 FT., B =      6.00 FT., XK =        .77 VFACT =      1.00
    QBKREF =        .00 FT.**3/SEC.
   IREF =        1, IMAX =     180, NTIMES =    10950, NS =      0
```

```
 .00E+00    2.00 .90E+05    2.00 .50E+05    2.00 .60E+05    3.00
 .90E+05    3.00 .10E+06    3.00 .14E+06    2.00
```

BACKGROUND EROSION TRANSPORT RATES

1	.000	2	.001	3	.001	4	.002	5	.003
6	.004	7	.004	8	.005	9	.006	10	.007
11	.007	12	.008	13	.009	14	.009	15	.010
16	.011	17	.012	18	.012	19	.013	20	.014
21	.015	22	.015	23	.016	24	.017	25	.018
26	.018	27	.019	28	.020	29	.020	30	.021
31	.022	32	.023	33	.023	34	.024	35	.025
36	.026	37	.026	38	.027	39	.028	40	.028
41	.029	42	.030	43	.031	44	.031	45	.032
46	.033	47	.034	48	.034	49	.035	50	.036
51	.036	52	.037	53	.038	54	.039	55	.039
56	.040	57	.041	58	.042	59	.042	60	.043
61	.044	62	.044	63	.045	64	.046	65	.047
66	.047	67	.048	68	.049	69	.050	70	.050
71	.051	72	.052	73	.053	74	.053	75	.054
76	.055	77	.055	78	.056	79	.057	80	.058
81	.058	82	.059	83	.060	84	.061	85	.061
86	.062	87	.063	88	.063	89	.064	90	.065
91	.066	92	.066	93	.067	94	.068	95	.069
96	.069	97	.070	98	.071	99	.071	100	.072
101	.073	102	.074	103	.074	104	.075	105	.076
106	.077	107	.077	108	.078	109	.079	110	.079
111	.080	112	.081	113	.082	114	.082	115	.083
116	.084	117	.085	118	.085	119	.086	120	.087
121	.088	122	.088	123	.089	124	.090	125	.090
126	.091	127	.092	128	.093	129	.093	130	.094
131	.095	132	.096	133	.096	134	.097	135	.098
136	.098	137	.099	138	.100	139	.101	140	.101
141	.102	142	.103	143	.104	144	.104	145	.105
146	.106	147	.106	148	.107	149	.108	150	.109
151	.109	152	.110	153	.111	154	.112	155	.112
156	.113	157	.114	158	.115	159	.115	160	.116
161	.117	162	.117	163	.118	164	.119	165	.120
166	.120	167	.121	168	[illegible]	169	.123	170	.123
171	.124	172	.125	173	99	174	.126	175	.127
176	.128	177	.128	178		179	.130	180	.131
181	.131								

80 100

INITIAL SHORELINE (INCL. NOURISHMENT) POSITION

1	0.	.00	2	500.	.00
3	1000.	.00	4	1500.	.00
5	2000.	.00	6	2500.	.00
7	3000.	.00	8	3500.	.00
9	4000.	.00	10	4500.	.00
11	5000.	.00	12	5500.	.00
13	6000.	.00	14	6500.	.00
15	7000.	.00	16	7500.	.00
17	8000.	.00	18	8500.	.00
19	9000.	.00	20	9500.	.00
21	10000.	.00	22	10500.	.00
23	11000.	.00	24	11500.	.00
25	12000.	.00	26	12500.	.00
27	13000.	.00	28	13500.	.00
29	14000.	.00	30	14500.	.00
31	15000.	.00	32	15500.	.00
33	16000.	.00	34	16500.	.00
35	17000.	.00	36	17500.	.00
37	18000.	.00	38	18500.	.00
39	19000.	.00	40	19500.	.00
41	20000.	.00	42	20500.	.00
43	21000.	.00	44	21500.	.00
45	22000.	.00	46	22500.	.00
47	23000.	.00	48	23500.	.00
49	24000.	.00	50	24500.	.00
51	25000.	.00	52	25500.	.00
53	26000.	.00	54	26500.	.00
55	27000.	.00	56	27500.	.00
57	28000.	.00	58	28500.	.00
59	29000.	.00	60	29500.	.00
61	30000.	.00	62	30500.	.00
63	31000.	.00	64	31500.	.00
65	32000.	.00	66	32500.	.00
67	33000.	.00	68	33500.	.00
69	34000.	.00	70	34500.	.00
71	35000.	.00	72	35500.	.00
73	36000.	.00	74	36500.	.00
75	37000.	.00	76	37500.	.00
77	38000.	.00	78	38500.	.00
79	39000.	.00	80	39500.	112.00
81	40000.	112.00	82	40500.	112.00
83	41000.	112.00	84	41500.	112.00
85	42000.	112.00	86	42500.	112.00
87	43000.	112.00	88	43500.	112.00
89	44000.	112.00	90	44500.	112.00
91	45000.	112.00	92	45500.	112.00
93	46000.	112.00	94	46500.	112.00
95	47000.	112.00	96	47500.	112.00
97	48000.	112.00	98	48500.	112.00
99	49000.	112.00	100	49500.	112.00
101	50000.	.00	102	50500.	.00
103	51000.	.00	104	51500.	.00
105	52000.	.00	106	52500.	.00
107	53000.	.00	108	53500.	.00
109	54000.	.00	110	54500.	.00
111	55000.	.00	112	55500.	.00
113	56000.	.00	114	56500.	.00
115	57000.	.00	116	100	.00
117	58000.	.00	118		.00
119	59000.	.00	120		.00
121	60000.	.00	122	60500.	.00
123	61000.	.00	124	61500.	.00

127	63000.	.00	128	63500.	.00
129	64000.	.00	130	64500.	.00
131	65000.	.00	132	65500.	.00
133	66000.	.00	134	66500.	.00
135	67000.	.00	136	67500.	.00
137	68000.	.00	138	68500.	.00
139	69000.	.00	140	69500.	.00
141	70000.	.00	142	70500.	.00
143	71000.	.00	144	71500.	.00
145	72000.	.00	146	72500.	.00
147	73000.	.00	148	73500.	.00
149	74000.	.00	150	74500.	.00
151	75000.	.00	152	75500.	.00
153	76000.	.00	154	76500.	.00
155	77000.	.00	156	77500.	.00
157	78000.	.00	158	78500.	.00
159	79000.	.00	160	79500.	.00
161	80000.	.00	162	80500.	.00
163	81000.	.00	164	81500.	.00
165	82000.	.00	166	82500.	.00
167	83000.	.00	168	83500.	.00
169	84000.	.00	170	84500.	.00
171	85000.	.00	172	85500.	.00
173	86000.	.00	174	86500.	.00
175	87000.	.00	176	87500.	.00
177	88000.	.00	178	88500.	.00
179	89000.	.00	180	89500.	.00

100 116 .000 .084 .000 -.542 -.542 .084 .000

TIME = 1 YEARS

1	-2.00	2	-2.00	3	-2.00	4	-2.00	5	-2.00	6	-2.00
7	-2.00	8	-2.00	9	-2.00	10	-2.00	11	-2.00	12	-2.00
13	-2.00	14	-2.00	15	-2.00	16	-2.00	17	-2.00	18	-2.00
19	-2.00	20	-2.00	21	-2.00	22	-2.00	23	-2.00	24	-2.00
25	-2.00	26	-2.00	27	-2.00	28	-2.00	29	-2.00	30	-2.00
31	-2.00	32	-2.00	33	-2.00	34	-2.00	35	-2.00	36	-2.00
37	-2.00	38	-2.00	39	-2.00	40	-2.00	41	-2.00	42	-2.00
43	-2.00	44	-2.00	45	-2.00	46	-2.00	47	-2.00	48	-2.00
49	-2.00	50	-2.00	51	-2.00	52	-2.00	53	-2.00	54	-2.00
55	-2.00	56	-2.00	57	-2.00	58	-2.00	59	-1.99	60	-1.98
61	-1.96	62	-1.93	63	-1.87	64	-1.77	65	-1.60	66	-1.31
67	-.87	68	-.18	69	.84	70	2.31	71	4.34	72	7.07
73	10.62	74	15.06	75	20.45	76	26.75	77	33.87	78	41.64
79	49.83	80	58.16	81	66.34	82	74.10	83	81.19	84	87.43
85	92.71	86	96.98	87	100.24	88	102.52	89	103.87	90	104.31
91	103.87	92	102.52	93	100.24	94	96.98	95	92.71	96	87.43
97	81.19	98	74.10	99	66.34	100	58.16	101	49.83	102	41.64
103	33.87	104	26.75	105	20.45	106	15.06	107	10.62	108	7.07
109	4.34	110	2.31	111	.84	112	-.18	113	-.87	114	-1.31
115	-1.60	116	-1.77	117	-1.87	118	-1.93	119	-1.96	120	-1.98
121	-1.99	122	-2.00	123	-2.00	124	-2.00	125	-2.00	126	-2.00
127	-2.00	128	-2.00	129	-2.00	130	-2.00	131	-2.00	132	-2.00
133	-2.00	134	-2.00	135	-2.00	136	-2.00	137	-2.00	138	-2.00
139	-2.00	140	-2.00	141	-2.00	142	-2.00	143	-2.00	144	-2.00
145	-2.00	146	-2.00	147	-2.00	148	-2.00	149	-2.00	150	-2.00
151	-2.00	152	-2.00	153	-2.00	154	-2.00	155	-2.00	156	-2.00
157	-2.00	158	-2.00	159	-2.00	160	-2.00	161	-2.00	162	-2.00
163	-2.00	164	-2.00	165	-2.00	166	-2.00	167	-2.00	168	-2.00
169	-2.00	170	-2.00	171	-2.00	172	-2.00	173	-2.00	174	-2.00
175	-2.00	176	-2.00	177	-2.00	178	-2.00	179	-2.00	180	-2.00

LCUR = 1 PCT(LCUR) = 78
LCUR = 2 PCT(LCUR) = 3
LCUR = 3 PCT(LCUR) = 0
LCUR = 4 PCT(LCUR) = 3

TIME = 5 YEARS

1	-10.00	2	-10.00	3	-10.00	4	-10.00	5	-10.00	6	-10.00

13	-10.00	14	-10.00	15	-10.00	16	-10.00	17	-10.00	18	-10.00
19	-10.00	20	-10.00	21	-10.00	22	-10.00	23	-10.00	24	-10.00
25	-10.00	26	-10.00	27	-10.00	28	-10.00	29	-10.00	30	-10.00
31	-10.00	32	-10.00	33	-9.99	34	-9.99	35	-9.99	36	-9.98
37	-9.98	38	-9.97	39	-9.96	40	-9.94	41	-9.92	42	-9.90
43	-9.86	44	-9.82	45	-9.77	46	-9.70	47	-9.61	48	-9.50
49	-9.37	50	-9.21	51	-9.00	52	-8.76	53	-8.46	54	-8.10
55	-7.68	56	-7.17	57	-6.58	58	-5.89	59	-5.09	60	-4.17
61	-3.12	62	-1.93	63	-.59	64	.91	65	2.57	66	4.40
67	6.41	68	8.58	69	10.91	70	13.41	71	16.05	72	18.82
73	21.71	74	24.70	75	27.75	76	30.84	77	33.93	78	37.00
79	40.01	80	42.92	81	45.69	82	48.29	83	50.69	84	52.84
85	54.71	86	56.29	87	57.54	88	58.45	89	59.00	90	59.18
91	59.00	92	58.45	93	57.54	94	56.29	95	54.71	96	52.84
97	50.69	98	48.29	99	45.69	100	42.92	101	40.01	102	37.00
103	33.93	104	30.84	105	27.75	106	24.70	107	21.71	108	18.82
109	16.05	110	13.41	111	10.91	112	8.58	113	6.41	114	4.40
115	2.57	116	.91	117	-.59	118	-1.93	119	-3.12	120	-4.17
121	-5.09	122	-5.89	123	-6.58	124	-7.17	125	-7.68	126	-8.10
127	-8.46	128	-8.76	129	-9.00	130	-9.21	131	-9.37	132	-9.50
133	-9.61	134	-9.70	135	-9.77	136	-9.82	137	-9.86	138	-9.90
139	-9.92	140	-9.94	141	-9.96	142	-9.97	143	-9.98	144	-9.98
145	-9.99	146	-9.99	147	-9.99	148	-10.00	149	-10.00	150	-10.00
151	-10.00	152	-10.00	153	-10.00	154	-10.00	155	-10.00	156	-10.00
157	-10.00	158	-10.00	159	-10.00	160	-10.00	161	-10.00	162	-10.00
163	-10.00	164	-10.00	165	-10.00	166	-10.00	167	-10.00	168	-10.00
169	-10.00	170	-10.00	171	-10.00	172	-10.00	173	-10.00	174	-10.00
175	-10.00	176	-10.00	177	-10.00	178	-10.00	179	-10.00	180	-10.00

LCUR = 5 PCT(LCUR) = .47
LCUR = 6 PCT(LCUR) = .42
LCUR = 7 PCT(LCUR) = .38
LCUR = 8 PCT(LCUR) = .33
LCUR = 9 PCT(LCUR) = .30

TIME = 10 YEARS

1	-20.00	2	-20.00	3	-20.00	4	-20.00	5	-20.00	6	-20.00
7	-20.00	8	-20.00	9	-20.00	10	-20.00	11	-20.00	12	-20.00
13	-19.99	14	-19.99	15	-19.99	16	-19.99	17	-19.99	18	-19.98
19	-19.98	20	-19.97	21	-19.97	22	-19.96	23	-19.95	24	-19.94
25	-19.92	26	-19.91	27	-19.89	28	-19.86	29	-19.83	30	-19.80
31	-19.76	32	-19.71	33	-19.65	34	-19.59	35	-19.51	36	-19.42
37	-19.31	38	-19.19	39	-19.05	40	-18.89	41	-18.70	42	-18.49
43	-18.25	44	-17.98	45	-17.68	46	-17.34	47	-16.96	48	-16.53
49	-16.05	50	-15.53	51	-14.95	52	-14.32	53	-13.62	54	-12.86
55	-12.04	56	-11.15	57	-10.19	58	-9.16	59	-8.06	60	-6.88
61	-5.64	62	-4.33	63	-2.96	64	-1.51	65	-.01	66	1.54
67	3.15	68	4.80	69	6.48	70	8.19	71	9.92	72	11.66
73	13.40	74	15.12	75	16.82	76	18.48	77	20.10	78	21.66
79	23.14	80	24.55	81	25.85	82	27.06	83	28.14	84	29.10
85	29.93	86	30.62	87	31.16	88	31.55	89	31.79	90	31.87
91	31.79	92	31.55	93	31.16	94	30.62	95	29.93	96	29.10
97	28.14	98	27.06	99	25.85	100	24.55	101	23.14	102	21.66
103	20.10	104	18.48	105	16.82	106	15.12	107	13.40	108	11.66
109	9.92	110	8.19	111	6.48	112	4.80	113	3.15	114	1.54
115	-.01	116	-1.51	117	-2.95	118	-4.33	119	-5.64	120	-6.88
121	-8.06	122	-9.16	123	-10.19	124	-11.15	125	-12.04	126	-12.86
127	-13.62	128	-14.31	129	-14.95	130	-15.53	131	-16.05	132	-16.53
133	-16.96	134	-17.34	135	-17.68	136	-17.98	137	-18.25	138	-18.49
139	-18.70	140	-18.89	141	-19.05	142	-19.19	143	-19.31	144	-19.42
145	-19.51	146	-19.59	147	-19.65	148	-19.71	149	-19.76	150	-19.80
151	-19.83	152	-19.86	153	-19[illegible]	[illegible]	-19.91	155	-19.92	156	-19.94
157	-19.95	158	-19.96	159	-19[illegible]	[illegible]	-19.97	161	-19.98	162	-19.98
163	-19.99	164	-19.99	165	[illegible]	[illegible]	-19.99	167	-19.99	168	-20.00
169	-20.00	170	-20.00	171	-20.00	172	-20.00	173	-20.00	174	-20.00
175	-20.00	176	-20.00	177	-20.00	178	-20.00	179	-20.00	180	-20.00

LCUR = 10 PCT(LCUR) = .26

```
    LCUR =      11  PCT(LCUR) =      [illegible]
    LCUR =      12  PCT(LCUR) =      .19
    LCUR =      13  PCT(LCUR) =      .16
    LCUR =      14  PCT(LCUR) =      .13
    LCUR =      15  PCT(LCUR) =      .10
    LCUR =      16  PCT(LCUR) =      .08
    LCUR =      17  PCT(LCUR) =      .05
    LCUR =      18  PCT(LCUR) =      .02
    LCUR =      19  PCT(LCUR) =      .00
    LCUR =      20  PCT(LCUR) =     -.03
    LCUR =      21  PCT(LCUR) =     -.05
    LCUR =      22  PCT(LCUR) =     -.08
    LCUR =      23  PCT(LCUR) =     -.10
    LCUR =      24  PCT(LCUR) =     -.13
    LCUR =      25  PCT(LCUR) =     -.15
    LCUR =      26  PCT(LCUR) =     -.17
    LCUR =      27  PCT(LCUR) =     -.20
    LCUR =      28  PCT(LCUR) =     -.22
    LCUR =      29  PCT(LCUR) =     -.24
                    TIME =       30  YEARS
  1  -59.99   2  -59.92   3  -59.84   4  -59.76   5  -59.68   6  -59.60
  7  -59.52   8  -59.43   9  -59.34  10  -59.24  11  -59.14  12  -59.04
 13  -58.93  14  -58.82  15  -58.69  16  -58.56  17  -58.43  18  -58.28
 19  -58.13  20  -57.97  21  -57.80  22  -57.62  23  -57.42  24  -57.22
 25  -57.01  26  -56.78  27  -56.54  28  -56.29  29  -56.02  30  -55.75
 31  -55.45  32  -55.15  33  -54.83  34  -54.49  35  -54.14  36  -53.78
 37  -53.40  38  -53.00  39  -52.59  40  -52.17  41  -51.72  42  -51.27
 43  -50.80  44  -50.31  45  -49.81  46  -49.30  47  -48.77  48  -48.23
 49  -47.68  50  -47.11  51  -46.54  52  -45.95  53  -45.36  54  -44.76
 55  -44.15  56  -43.53  57  -42.91  58  -42.28  59  -41.66  60  -41.03
 61  -40.40  62  -39.77  63  -39.15  64  -38.53  65  -37.92  66  -37.31
 67  -36.71  68  -36.13  69  -35.55  70  -34.99  71  -34.45  72  -33.92
 73  -33.41  74  -32.92  75  -32.46  76  -32.01  77  -31.59  78  -31.19
 79  -30.83  80  -30.49  81  -30.17  82  -29.89  83  -29.64  84  -29.42
 85  -29.24  86  -29.08  87  -28.97  88  -28.88  89  -28.83  90  -28.81
 91  -28.83  92  -28.88  93  -28.97  94  -29.08  95  -29.24  96  -29.42
 97  -29.64  98  -29.89  99  -30.17 100  -30.49 101  -30.83 102  -31.19
103  -31.59 104  -32.01 105  -32.45 106  -32.92 107  -33.41 108  -33.92
109  -34.45 110  -34.99 111  -35.55 112  -36.13 113  -36.71 114  -37.31
115  -37.92 116  -38.53 117  -39.15 118  -39.77 119  -40.40 120  -41.03
121  -41.66 122  -42.28 123  -42.91 124  -43.53 125  -44.15 126  -44.76
127  -45.36 128  -45.95 129  -46.54 130  -47.11 131  -47.68 132  -48.23
133  -48.77 134  -49.30 135  -49.81 136  -50.31 137  -50.80 138  -51.27
139  -51.72 140  -52.16 141  -52.59 142  -53.00 143  -53.40 144  -53.78
145  -54.14 146  -54.49 147  -54.83 148  -55.15 149  -55.45 150  -55.74
151  -56.02 152  -56.28 153  -56.54 154  -56.77 155  -57.00 156  -57.21
157  -57.42 158  -57.61 159  -57.79 160  -57.96 161  -58.12 162  -58.27
163  -58.41 164  -58.55 165  -58.68 166  -58.80 167  -58.91 168  -59.02
169  -59.12 170  -59.21 171  -59.31 172  -59.39 173  -59.48 174  -59.56
175  -59.63 176  -59.71 177  -59.78 178  -59.85 179  -59.92 180  -59.99
    LCUR =      30  PCT(LCUR) =     -.26
```

APPENDIX E

NUMERICAL EXAMPLE 3

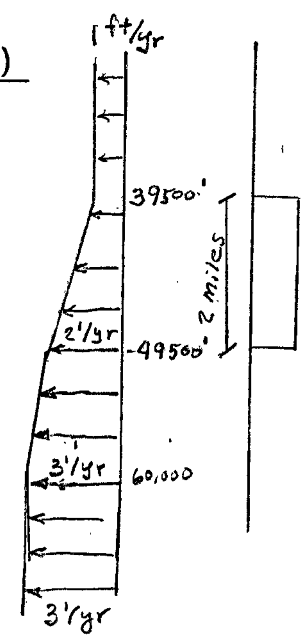
BEACH NOURISHMENT PROJECTION
(Numerical Procedure)

General Location: *Example 3*

Wave Height, H_0 (Fig. 22):	2.0 ft.,	Closure Depth, h_* (Fig. 8):	17 ft.
Wave Period, T (Fig. 23):	6.0 sec.,	Berm Height, B:	6 ft.
Wave Direction, α_0:	90 °,	Sand Diameter, D:	0.35 mm
Deep Water Contour Orientation, β_0:	90 °,	Transport Factor, K (Fig. 5):	0.77
Longshore Axis Orientation, μ:	180 °,	VFACT:	1.0
Grid Dimension, Δx:	500 ft	Background Transport, QREF:	0 ft^3/s
Time Increment, Δt:	86400 sec	IREF:	1
		IMAX:	180
		NTIMES:	10950
		No. of Structures, NS:	0

Structure Specificiation / **Background Erosion**

Structure Number	Structure Location, I	Structure Length (ft)	x	Erosion Rate, ER, (ft/yr)
1			0.0	1.0
2			39500	1.0
3			49500	2.0
4			60,000	3.0
5			90,000	3.0
6				



Equilibrated Beach Width Δy_0

A_N (Fig. 7) or From Profile:	$ft^{1/3}$
A_F (Fig. 7):	$ft^{1/3}$
Volume Per Unit Length:	ft^3/ft
Δy_0 (Figs. 11 and 12):	112 ft

Nourishment Specification

I Range			Δy_0
80	to	100	112.0
	to		
	to		
	to		
	to		

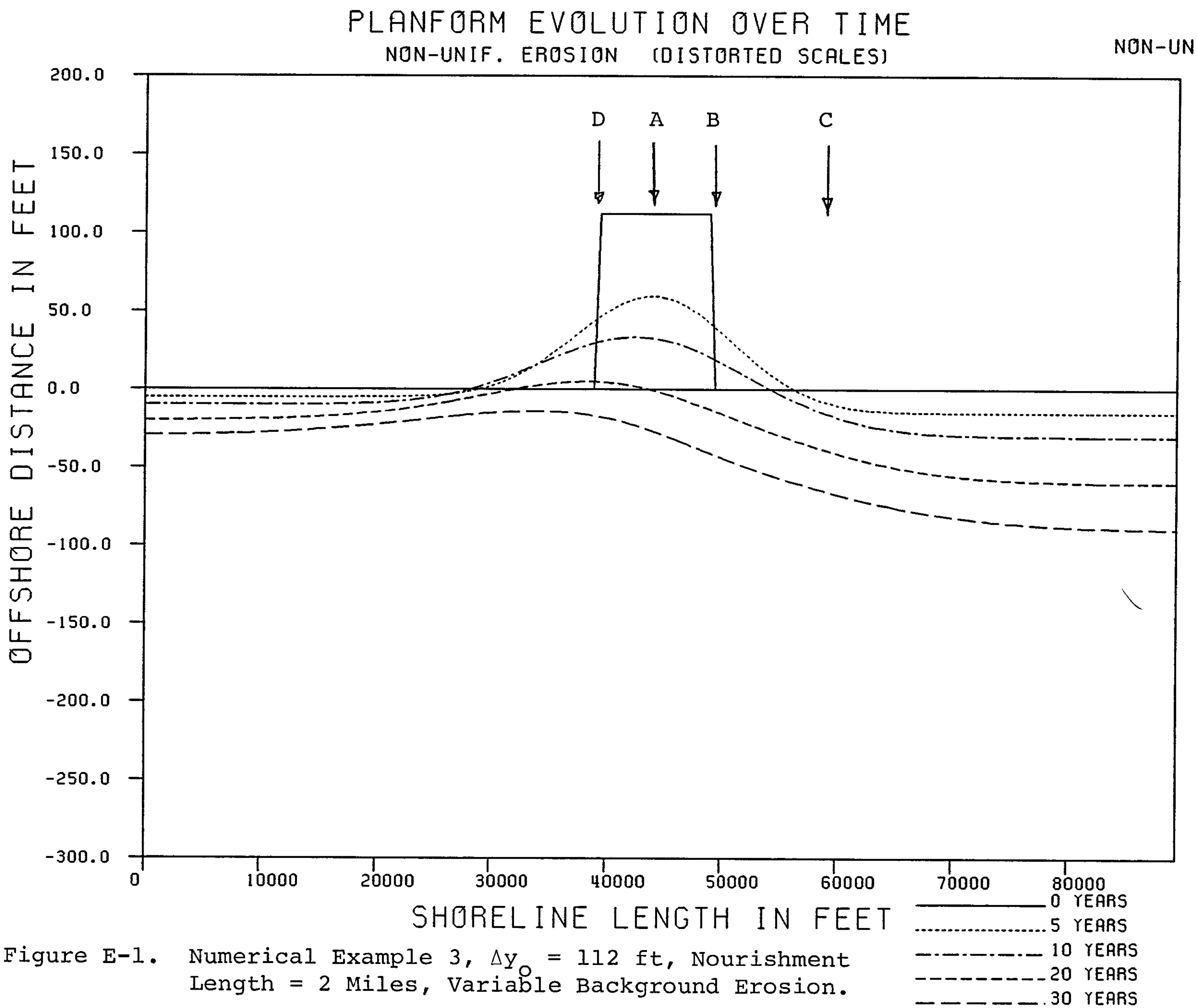


Figure E-1. Numerical Example 3, Δy_o = 112 ft, Nourishment Length = 2 Miles, Variable Background Erosion.

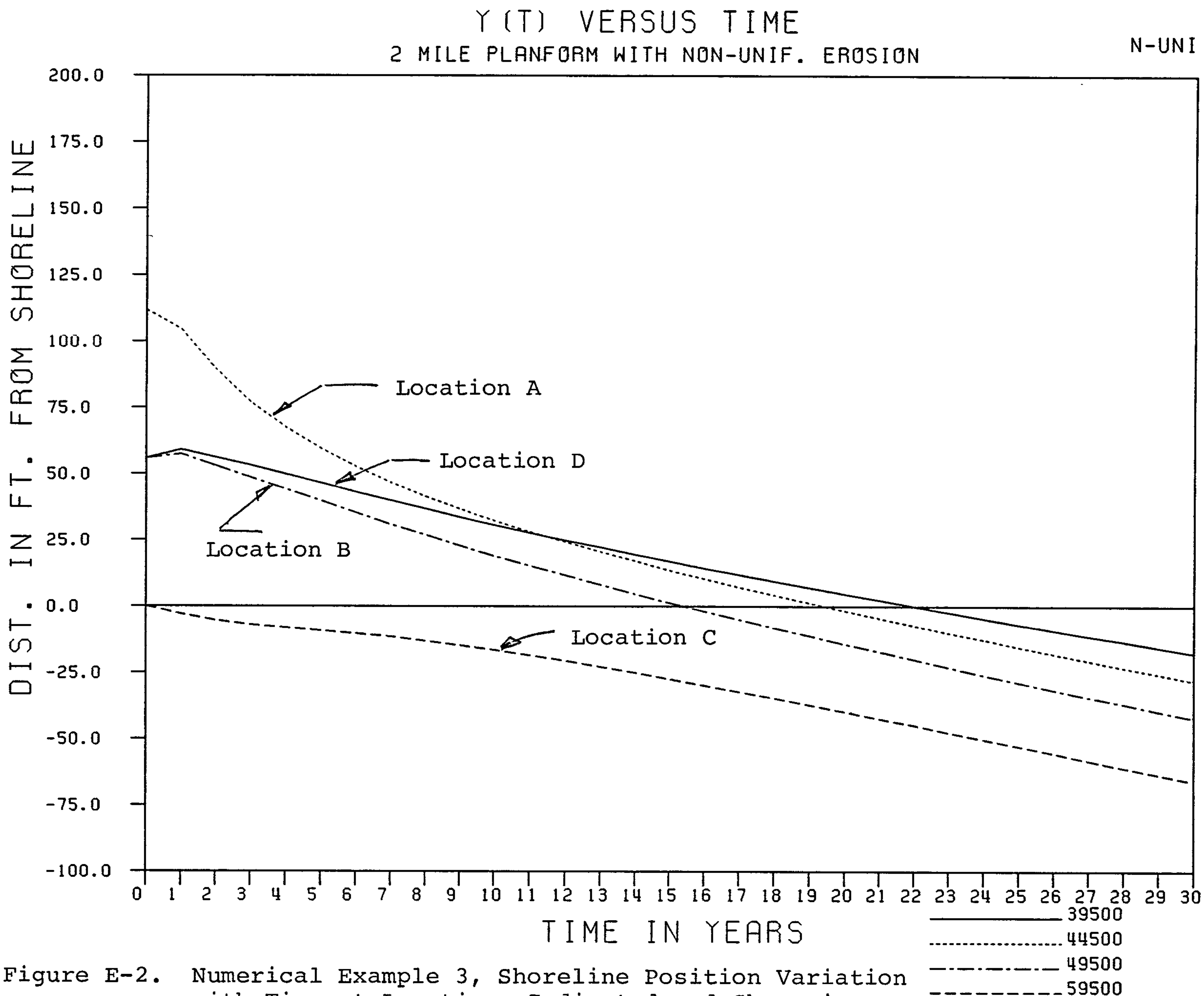


Figure E-2. Numerical Example 3, Shoreline Position Variation with Time at Locations Indicated and Shown in Figure E-1.

INPUT FILE: DNRBS.INP
(Example No. 3)

```
  EXAMPLE NO. 3 VAR. BACK. EROS. NO STRUC. 2 MILE PROJ.
  2.00      6.0     90.0     90.0    180.0    500.0 86400.0
  17.0      6.0     0.77      1.0      0.0      1   180 10950      0
   0.0      1.0  39500.       1.0   49500.      2.0  60000.       3.0
90000.      3.0 100000.       3.0 140000.       2.0
  80   100
  80   112.0
  81   112.0
  82   112.0
  83   112.0
  84   112.0
  85   112.0
  86   112.0
  87   112.0
  88   112.0
  89   112.0
  90   112.0
  91   112.0
  92   112.0
  93   112.0
  94   112.0
  95   112.0
  96   112.0
  97   112.0
  98   112.0
  99   112.0
 100   112.0
```

OUTPUT FILE: DNRBS.OUT
(Example No. 3)

EXAMPLE NO. 3 VAR. BACK. EROS. NO STRUC. 2 MILE PROJ.

```
 HO =   2.00 FT., T =   6.00 SEC.,  ALPO =   90.00 DEG., BTAO =   90.00 DEG.,
XMU =  180.00 DEG., DX =   500.00 FT., DT = 86400.00 SEC.
 HSTR =     17.00 FT., B =      6.00 FT., XK =       .77 VFACT =      1.00
    QBKREF =       .00 FT.**3/SEC.
   IREF =       1, IMAX =     180, NTIMES =    10950, NS =      0


 .00E+00     1.00 .40E+05     1.00 .50E+05     2.00 .60E+05     3.00
 .90E+05     3.00 .10E+06     3.00 .14E+06     2.00
```

BACKGROUND EROSION TRANSPORT RATES

1	.000	2	.000	3	.001	4	.001	5	.001
6	.002	7	.002	8	.003	9	.003	10	.003
11	.004	12	.004	13	.004	14	.005	15	.005
16	.005	17	.006	18	.006	19	.007	20	.007
21	.007	22	.008	23	.008	24	.008	25	.009
26	.009	27	.009	28	.010	29	.010	30	.011
31	.011	32	.011	33	.012	34	.012	35	.012
36	.013	37	.013	38	.013	39	.014	40	.014
41	.015	42	.015	43	.015	44	.016	45	.016
46	.016	47	.017	48	.017	49	.018	50	.018
51	.018	52	.019	53	.019	54	.019	55	.020
56	.020	57	.020	58	.021	59	.021	60	.022
61	.022	62	.022	63	.023	64	.023	65	.023
66	.024	67	.024	68	.024	69	.025	70	.025
71	.026	72	.026	73	.026	74	.027	75	.027
76	.027	77	.028	78	.028	79	.028	80	.029
81	.029	82	.030	83	.030	84	.030	85	.031
86	.031	87	.032	88	.032	89	.033	90	.033
91	.034	92	.034	93	.035	94	.036	95	.036
96	.037	97	.037	98	.038	99	.039	100	.040
101	.040	102	.041	103	.042	104	.043	105	.043
106	.044	107	.045	108	.046	109	.047	110	.048
111	.049	112	.049	113	.050	114	.051	115	.052
116	.053	117	.054	118	.055	119	.056	120	.057
121	.059	122	.060	123	.061	124	.062	125	.063
126	.064	127	.065	128	.066	129	.067	130	.068
131	.069	132	.071	133	.072	134	.073	135	.074
136	.075	137	.076	138	.077	139	.078	140	.079
141	.080	142	.082	143	.083	144	.084	145	.085
146	.086	147	.087	148	.088	149	.089	150	.090
151	.091	152	.092	153	.094	154	.095	155	.096
156	.097	157	.098	158	.099	159	.100	160	.101
161	.102	162	.103	163	.104	164	.106	165	.107
166	.108	167	.109	168	.110	169	.111	170	.112
171	.113	172	.114	173		174	.117	175	.118
176	.119	177	.120	178		179	.122	180	.123
181	.124								

80 100

INITIAL SHORELINE (INCL. NOURISHMENT) POSITION

1	0.	.00	2	500.	.00
3	1000.	.00	4	1500.	.00
5	2000.	.00	6	2500.	.00
7	3000.	.00	8	3500.	.00
9	4000.	.00	10	4500.	.00
11	5000.	.00	12	5500.	.00
13	6000.	.00	14	6500.	.00
15	7000.	.00	16	7500.	.00
17	8000.	.00	18	8500.	.00
19	9000.	.00	20	9500.	.00
21	10000.	.00	22	10500.	.00
23	11000.	.00	24	11500.	.00
25	12000.	.00	26	12500.	.00
27	13000.	.00	28	13500.	.00
29	14000.	.00	30	14500.	.00
31	15000.	.00	32	15500.	.00
33	16000.	.00	34	16500.	.00
35	17000.	.00	36	17500.	.00
37	18000.	.00	38	18500.	.00
39	19000.	.00	40	19500.	.00
41	20000.	.00	42	20500.	.00
43	21000.	.00	44	21500.	.00
45	22000.	.00	46	22500.	.00
47	23000.	.00	48	23500.	.00
49	24000.	.00	50	24500.	.00
51	25000.	.00	52	25500.	.00
53	26000.	.00	54	26500.	.00
55	27000.	.00	56	27500.	.00
57	28000.	.00	58	28500.	.00
59	29000.	.00	60	29500.	.00
61	30000.	.00	62	30500.	.00
63	31000.	.00	64	31500.	.00
65	32000.	.00	66	32500.	.00
67	33000.	.00	68	33500.	.00
69	34000.	.00	70	34500.	.00
71	35000.	.00	72	35500.	.00
73	36000.	.00	74	36500.	.00
75	37000.	.00	76	37500.	.00
77	38000.	.00	78	38500.	.00
79	39000.	.00	80	39500.	112.00
81	40000.	112.00	82	40500.	112.00
83	41000.	112.00	84	41500.	112.00
85	42000.	112.00	86	42500.	112.00
87	43000.	112.00	88	43500.	112.00
89	44000.	112.00	90	44500.	112.00
91	45000.	112.00	92	45500.	112.00
93	46000.	112.00	94	46500.	112.00
95	47000.	112.00	96	47500.	112.00
97	48000.	112.00	98	48500.	112.00
99	49000.	112.00	100	49500.	112.00
101	50000.	.00	102	50500.	.00
103	51000.	.00	104	51500.	.00
105	52000.	.00	106	52500.	.00
107	53000.	.00	108	53500.	.00
109	54000.	.00	110	54500.	.00
111	55000.	.00	112	55500.	.00
113	56000.	.00	114	56500.	.00
115	57000.	.00	116	57500.	.00
117	58000.	.00	118	[illegible]	.00
119	59000.	.00	120	[illegible]	.00
121	60000.	.00	122	[illegible]	.00
123	61000.	.00	124	61500.	.00

125	62000.	.00	126	62500.	.00
127	63000.	.00	128	63500.	.00
129	64000.	.00	130	64500.	.00
131	65000.	.00	132	65500.	.00
133	66000.	.00	134	66500.	.00
135	67000.	.00	136	67500.	.00
137	68000.	.00	138	68500.	.00
139	69000.	.00	140	69500.	.00
141	70000.	.00	142	70500.	.00
143	71000.	.00	144	71500.	.00
145	72000.	.00	146	72500.	.00
147	73000.	.00	148	73500.	.00
149	74000.	.00	150	74500.	.00
151	75000.	.00	152	75500.	.00
153	76000.	.00	154	76500.	.00
155	77000.	.00	156	77500.	.00
157	78000.	.00	158	78500.	.00
159	79000.	.00	160	79500.	.00
161	80000.	.00	162	80500.	.00
163	81000.	.00	164	81500.	.00
165	82000.	.00	166	82500.	.00
167	83000.	.00	168	83500.	.00
169	84000.	.00	170	84500.	.00
171	85000.	.00	172	85500.	.00
173	86000.	.00	174	86500.	.00
175	87000.	.00	176	87500.	.00
177	88000.	.00	178	88500.	.00
179	89000.	.00	180	89500.	.00

100 116 .000 .053 .000 -.736 -.749 .053 .000

TIME = 1 YEARS

1	-1.00	2	-1.00	3	-1.00	4	-1.00	5	-1.00	6	-1.00
7	-1.00	8	-1.00	9	-1.00	10	-1.00	11	-1.00	12	-1.00
13	-1.00	14	-1.00	15	-1.00	16	-1.00	17	-1.00	18	-1.00
19	-1.00	20	-1.00	21	-1.00	22	-1.00	23	-1.00	24	-1.00
25	-1.00	26	-1.00	27	-1.00	28	-1.00	29	-1.00	30	-1.00
31	-1.00	32	-1.00	33	-1.00	34	-1.00	35	-1.00	36	-1.00
37	-1.00	38	-1.00	39	-1.00	40	-1.00	41	-1.00	42	-1.00
43	-1.00	44	-1.00	45	-1.00	46	-1.00	47	-1.00	48	-1.00
49	-1.00	50	-1.00	51	-1.00	52	-1.00	53	-1.00	54	-1.00
55	-1.00	56	-1.00	57	-1.00	58	-1.00	59	-.99	60	-.98
61	-.96	62	-.93	63	-.87	64	-.77	65	-.60	66	-.31
67	.13	68	.82	69	1.84	70	3.31	71	5.34	72	8.07
73	11.61	74	16.06	75	21.44	76	27.73	77	34.84	78	42.60
79	50.78	80	59.09	81	67.24	82	74.96	83	82.01	84	88.21
85	93.45	86	97.67	87	100.89	88	103.12	89	104.42	90	104.81
91	104.32	92	102.92	93	100.59	94	97.28	95	92.96	96	87.63
97	81.34	98	74.20	99	66.39	100	58.16	101	49.78	102	41.54
103	33.72	104	26.56	105	20.21	106	14.78	107	10.28	108	6.69
109	3.91	110	1.83	111	.32	112	-.75	113	-1.48	114	-1.98
115	-2.31	116	-2.52	117	-2.67	118	-2.77	119	-2.84	120	-2.89
121	-2.92	122	-2.95	123	-2.97	124	-2.98	125	-2.99	126	-2.99
127	-2.99	128	-3.00	129	-3.00	130	-3.00	131	-3.00	132	-3.00
133	-3.00	134	-3.00	135	-3.00	136	-3.00	137	-3.00	138	-3.00
139	-3.00	140	-3.00	141	-3.00	142	-3.00	143	-3.00	144	-3.00
145	-3.00	146	-3.00	147	-3.00	148	-3.00	149	-3.00	150	-3.00
151	-3.00	152	-3.00	153	-3.00	154	-3.00	155	-3.00	156	-3.00
157	-3.00	158	-3.00	159	-3.00	160	-3.00	161	-3.00	162	-3.00
163	-3.00	164	-3.00	165	-3.00	166	-3.00	167	-3.00	168	-3.00
169	-3.00	170	-3.00	171	-3.00	172	-3.00	173	-3.00	174	-3.00
175	-3.00	176	-3.00	177	-3.00	178	-3.00	179	-3.00	180	-3.00

LCUR = 1 PCT(LCUR) = .78
LCUR = 2 PCT(LCUR) =
LCUR = 3 PCT(LCUR) = 111
LCUR = 4 PCT(LCUR) =

TIME = 5 YEARS

1	-5.00	2	-5.00	3	-5.00	4	-5.00	5	-5.00	6	-5.00

7	[illegible]	8	[illegible]	9	[illegible]	10	[illegible]	11	[illegible]	12	[illegible]
13	-5.00	14	-5.00	15	-5.00	16	-5.00	17	-5.00	18	-5.00
19	-5.00	20	-5.00	21	-5.00	22	-5.00	23	-5.00	24	-5.00
25	-5.00	26	-5.00	27	-5.00	28	-5.00	29	-5.00	30	-5.00
31	-5.00	32	-5.00	33	-4.99	34	-4.99	35	-4.99	36	-4.98
37	-4.98	38	-4.97	39	-4.96	40	-4.94	41	-4.92	42	-4.90
43	-4.86	44	-4.82	45	-4.77	46	-4.70	47	-4.61	48	-4.51
49	-4.37	50	-4.21	51	-4.00	52	-3.76	53	-3.46	54	-3.11
55	-2.68	56	-2.18	57	-1.59	58	-.90	59	-.10	60	.81
61	1.86	62	3.04	63	4.38	64	5.87	65	7.52	66	9.34
67	11.33	68	13.48	69	15.80	70	18.27	71	20.88	72	23.62
73	26.47	74	29.41	75	32.40	76	35.42	77	38.44	78	41.42
79	44.33	80	47.12	81	49.76	82	52.22	83	54.45	84	56.42
85	58.12	86	59.50	87	60.55	88	61.25	89	61.59	90	61.55
91	61.14	92	60.37	93	59.23	94	57.74	95	55.93	96	53.82
97	51.43	98	48.80	99	45.96	100	42.95	101	39.81	102	36.56
103	33.26	104	29.93	105	26.61	106	23.32	107	20.11	108	17.00
109	14.00	110	11.14	111	8.43	112	5.88	113	3.51	114	1.30
115	-.72	116	-2.57	117	-4.24	118	-5.75	119	-7.09	120	-8.29
121	-9.33	122	-10.24	123	-11.03	124	-11.71	125	-12.28	126	-12.77
127	-13.18	128	-13.53	129	-13.81	130	-14.05	131	-14.24	132	-14.40
133	-14.53	134	-14.63	135	-14.71	136	-14.78	137	-14.83	138	-14.87
139	-14.90	140	-14.92	141	-14.94	142	-14.96	143	-14.97	144	-14.98
145	-14.98	146	-14.99	147	-14.99	148	-14.99	149	-15.00	150	-15.00
151	-15.00	152	-15.00	153	-15.00	154	-15.00	155	-15.00	156	-15.00
157	-15.00	158	-15.00	159	-15.00	160	-15.00	161	-15.00	162	-15.00
163	-15.00	164	-15.00	165	-15.00	166	-15.00	167	-15.00	168	-15.00
169	-15.00	170	-15.00	171	-15.00	172	-15.00	173	-15.00	174	-15.00
175	-15.00	176	-15.00	177	-15.00	178	-15.00	179	-15.00	180	-15.00

LCUR = 5 PCT(LCUR) = .49
LCUR = 6 PCT(LCUR) = .45
LCUR = 7 PCT(LCUR) = .40
LCUR = 8 PCT(LCUR) = .37
LCUR = 9 PCT(LCUR) = .33
TIME = 10 YEARS

1	-10.00	2	-10.00	3	-10.00	4	-10.00	5	-10.00	6	-10.00
7	-10.00	8	-10.00	9	-10.00	10	-10.00	11	-10.00	12	-10.00
13	-9.99	14	-9.99	15	-9.99	16	-9.99	17	-9.99	18	-9.98
19	-9.98	20	-9.97	21	-9.97	22	-9.96	23	-9.95	24	-9.94
25	-9.92	26	-9.91	27	-9.89	28	-9.86	29	-9.83	30	-9.80
31	-9.76	32	-9.71	33	-9.65	34	-9.59	35	-9.51	36	-9.42
37	-9.31	38	-9.19	39	-9.05	40	-8.89	41	-8.71	42	-8.50
43	-8.26	44	-8.00	45	-7.69	46	-7.35	47	-6.97	48	-6.55
49	-6.08	50	-5.56	51	-4.99	52	-4.36	53	-3.67	54	-2.92
55	-2.11	56	-1.23	57	-.29	58	.72	59	1.80	60	2.95
61	4.16	62	5.44	63	6.79	64	8.19	65	9.64	66	11.15
67	12.69	68	14.28	69	15.89	70	17.51	71	19.15	72	20.78
73	22.40	74	24.00	75	25.56	76	27.06	77	28.50	78	29.86
79	31.13	80	32.30	81	33.35	82	34.27	83	35.05	84	35.70
85	36.19	86	36.53	87	36.71	88	36.72	89	36.57	90	36.25
91	35.76	92	35.11	93	34.30	94	33.33	95	32.21	96	30.94
97	29.54	98	28.02	99	26.37	100	24.62	101	22.78	102	20.85
103	18.86	104	16.81	105	14.71	106	12.58	107	10.43	108	8.28
109	6.13	110	4.00	111	1.89	112	-.18	113	-2.20	114	-4.17
115	-6.08	116	-7.92	117	-9.68	118	-11.37	119	-12.97	120	-14.48
121	-15.90	122	-17.23	123	-18.47	124	-19.61	125	-20.67	126	-21.65
127	-22.55	128	-23.37	129	-24.11	130	-24.79	131	-25.41	132	-25.96
133	-26.46	134	-26.90	135	-27.30	136	-27.66	137	-27.97	138	-28.25
139	-28.49	140	-28.70	141	-28.89	142	-29.05	143	-29.20	144	-29.32
145	-29.42	146	-29.51	147	-29.59	148	-29.66	149	-29.71	150	-29.76
151	-29.80	152	-29.84	153	-29.87	154	-29.89	155	-29.91	156	-29.93
157	-29.94	158	-29.95	159	-29.96	160	-29.97	161	-29.97	162	-29.98
163	-29.98	164	-29.99	165	-29.9		-29.99	167	-29.99	168	-29.99
169	-30.00	170	-30.00	171	-30.0	112	-30.00	173	-30.00	174	-30.00
175	-30.00	176	-30.00	177	-30.0		-30.00	179	-30.00	180	-30.00

LCUR = 10 PCT(LCUR) = .30

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   LCUR =      11  PCT(LCUR) =      .27
   LCUR =      12  PCT(LCUR) =      .24
   LCUR =      13  PCT(LCUR) =      .21
   LCUR =      14  PCT(LCUR) =      .18
   LCUR =      15  PCT(LCUR) =      .16
   LCUR =      16  PCT(LCUR) =      .13
   LCUR =      17  PCT(LCUR) =      .11
   LCUR =      18  PCT(LCUR) =      .08
   LCUR =      19  PCT(LCUR) =      .06
   LCUR =      20  PCT(LCUR) =      .04
   LCUR =      21  PCT(LCUR) =      .01
   LCUR =      22  PCT(LCUR) =     -.01
   LCUR =      23  PCT(LCUR) =     -.03
   LCUR =      24  PCT(LCUR) =     -.05
   LCUR =      25  PCT(LCUR) =     -.07
   LCUR =      26  PCT(LCUR) =     -.09
   LCUR =      27  PCT(LCUR) =     -.11
   LCUR =      28  PCT(LCUR) =     -.13
   LCUR =      29  PCT(LCUR) =     -.15
                   TIME =        30  YEARS
  1  -30.00   2  -29.92   3  -29.85   4  -29.77   5  -29.69   6  -29.61
  7  -29.53   8  -29.45   9  -29.36  10  -29.27  11  -29.17  12  -29.07
 13  -28.96  14  -28.85  15  -28.73  16  -28.61  17  -28.48  18  -28.34
 19  -28.19  20  -28.04  21  -27.88  22  -27.70  23  -27.52  24  -27.33
 25  -27.13  26  -26.91  27  -26.69  28  -26.45  29  -26.21  30  -25.95
 31  -25.68  32  -25.39  33  -25.10  34  -24.79  35  -24.47  36  -24.14
 37  -23.79  38  -23.44  39  -23.07  40  -22.69  41  -22.30  42  -21.89
 43  -21.48  44  -21.06  45  -20.63  46  -20.19  47  -19.74  48  -19.29
 49  -18.83  50  -18.37  51  -17.90  52  -17.44  53  -16.97  54  -16.50
 55  -16.04  56  -15.58  57  -15.12  58  -14.68  59  -14.24  60  -13.82
 61  -13.41  62  -13.02  63  -12.65  64  -12.30  65  -11.97  66  -11.67
 67  -11.39  68  -11.15  69  -10.94  70  -10.77  71  -10.64  72  -10.55
 73  -10.50  74  -10.50  75  -10.55  76  -10.65  77  -10.81  78  -11.02
 79  -11.30  80  -11.64  81  -12.04  82  -12.51  83  -13.04  84  -13.63
 85  -14.28  86  -15.00  87  -15.77  88  -16.60  89  -17.48  90  -18.41
 91  -19.40  92  -20.44  93  -21.52  94  -22.65  95  -23.83  96  -25.04
 97  -26.30  98  -27.59  99  -28.91 100  -30.27 101  -31.65 102  -33.06
103  -34.50 104  -35.95 105  -37.42 106  -38.91 107  -40.41 108  -41.91
109  -43.43 110  -44.94 111  -46.45 112  -47.96 113  -49.46 114  -50.96
115  -52.43 116  -53.89 117  -55.33 118  -56.75 119  -58.14 120  -59.50
121  -60.83 122  -62.11 123  -63.37 124  -64.58 125  -65.76 126  -66.90
127  -68.01 128  -69.08 129  -70.11 130  -71.11 131  -72.08 132  -73.01
133  -73.90 134  -74.76 135  -75.59 136  -76.39 137  -77.15 138  -77.88
139  -78.58 140  -79.25 141  -79.89 142  -80.50 143  -81.08 144  -81.64
145  -82.16 146  -82.67 147  -83.14 148  -83.59 149  -84.02 150  -84.43
151  -84.81 152  -85.17 153  -85.52 154  -85.84 155  -86.14 156  -86.43
157  -86.70 158  -86.95 159  -87.19 160  -87.41 161  -87.62 162  -87.82
163  -88.01 164  -88.18 165  -88.34 166  -88.50 167  -88.64 168  -88.78
169  -88.91 170  -89.03 171  -89.14 172  -89.25 173  -89.36 174  -89.46
175  -89.55 176  -89.64 177  -89.73 178  -89.82 179  -89.91 180  -90.00
   LCUR =      30  PCT(LCUR) =     -.17
```

APPENDIX F

NUMERICAL EXAMPLE 4

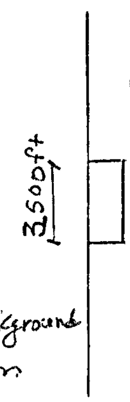
BEACH NOURISHMENT PROJECTION
(Numerical Procedure)

General Location: Example 4

Wave Height, H_0 (Fig. 22):	2.0 ft.,	Closure Depth, h_* (Fig. 8):	17 ft.
Wave Period, T (Fig. 23):	6.0 sec.,	Berm Height, B:	6 ft.
Wave Direction, α_0:	90 °,	Sand Diameter, D:	0.35 mm
Deep Water Contour Orientation, β_0:	90 °,	Transport Factor, K (Fig. 5):	0.77
Longshore Axis Orientation, μ:	180 °,	VFACT:	1.0
Grid Dimension, Δx:	500 ft	Background Transport, QREF:	0 ft^3/s
Time Increment, Δt:	86,400 sec	IREF:	1
		IMAX:	180
		NTIMES:	10950
		No. of Structures, NS:	0

Structure Specificiation / **Background Erosion**

Structure Number	Structure Location, I	Structure Length (ft)	x (ft)	Erosion Rate, ER, (ft/yr)
1	—	—	0.0	0.0
2			90000	0.0
3				
4				
5				
6				



No Background Erosion

Equilibrated Beach Width Δy_0 / **Nourishment Specification**

		I Range	Δy_0
A_N (Fig. 7) or From Profile:	______ $ft^{1/3}$	87 to 93	112
A_F (Fig. 7):	______ $ft^{1/3}$	to	
Volume Per Unit Length:	______ ft^3/ft	to	
Δy_0 (Figs. 11 and 12):	112 ft	to	
		to	

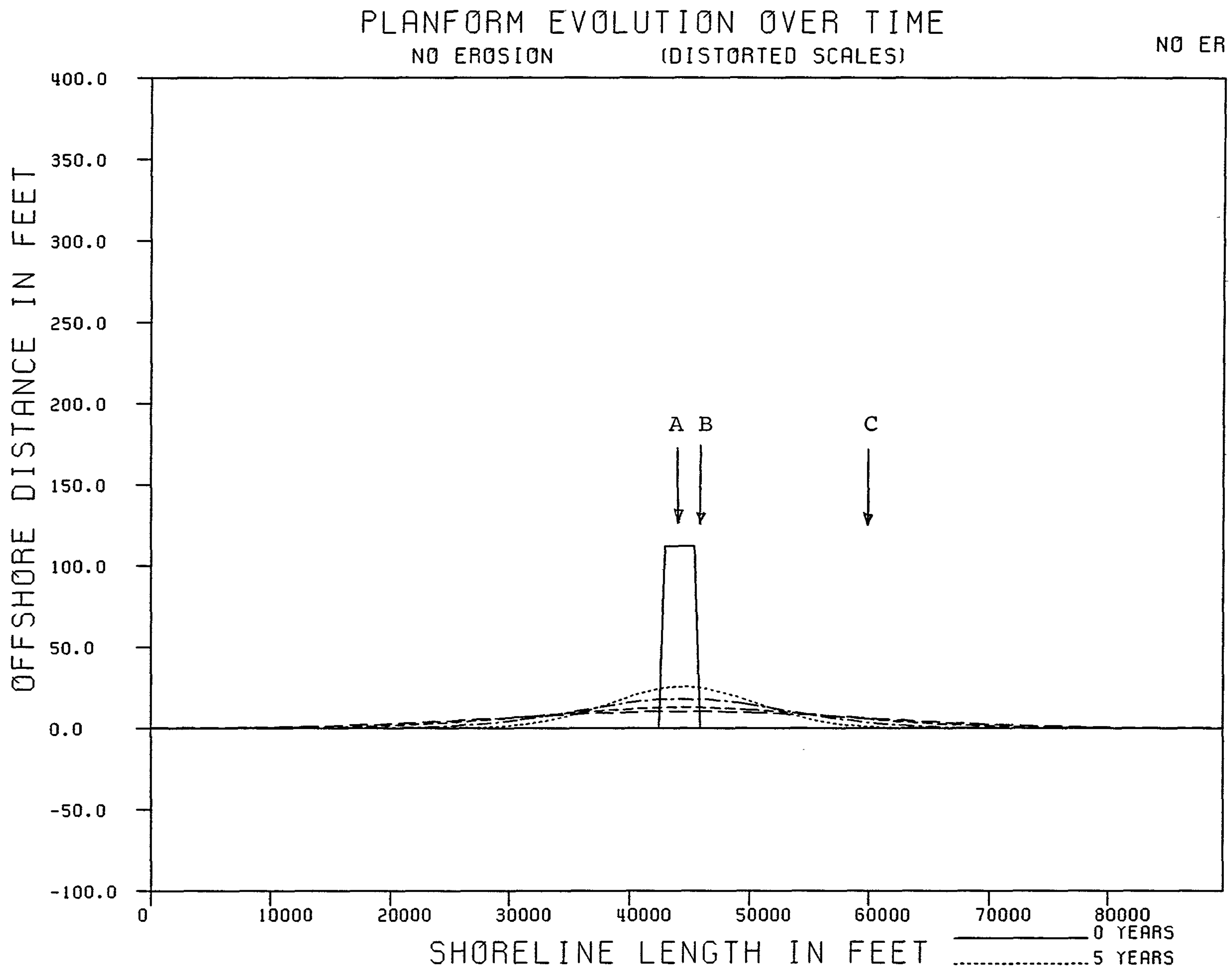


Figure F-1. Numerical Example 4, Δy_o = 112 ft, Nourishment Length = 1,000 ft, No Background Erosion.

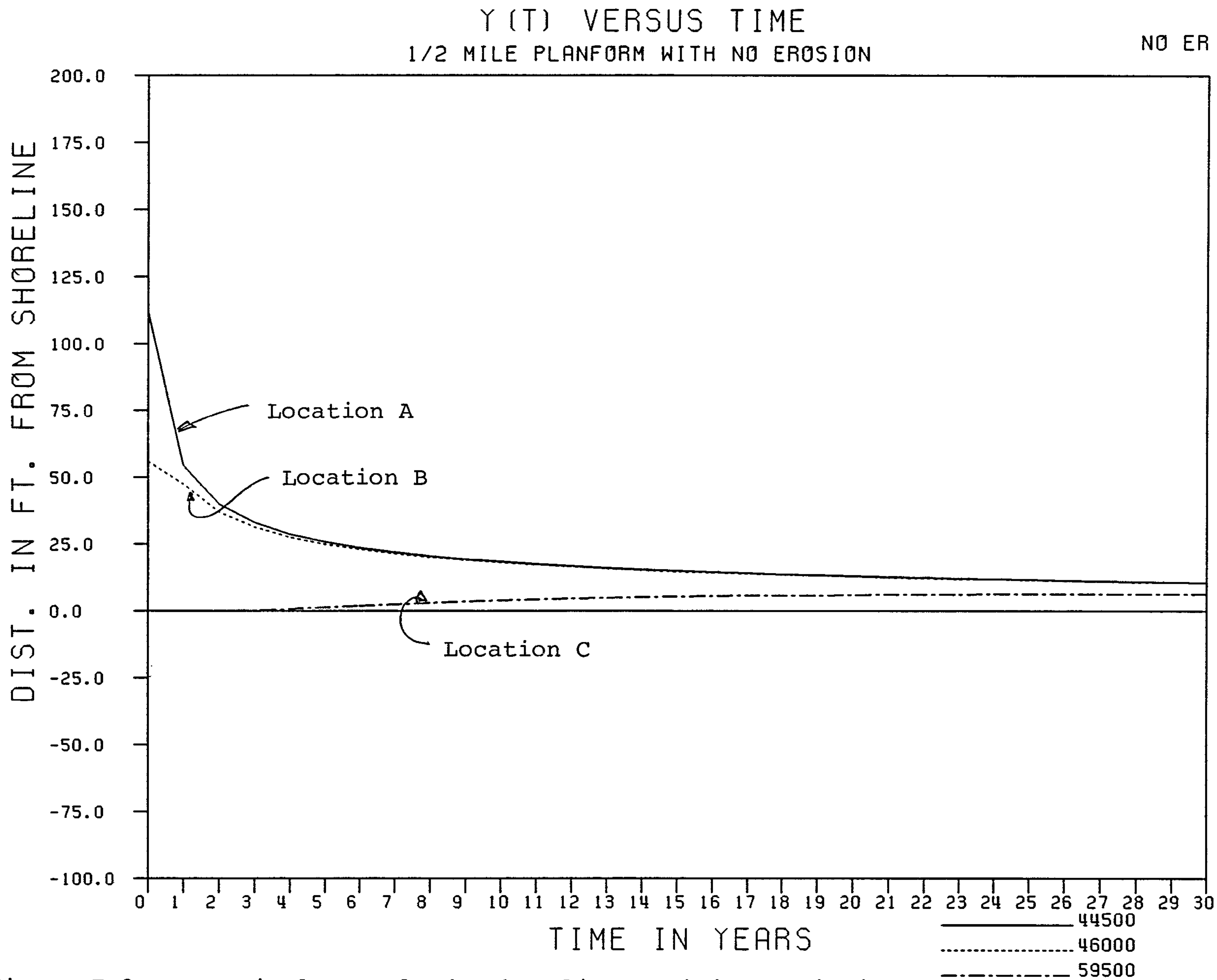


Figure F-2. Numerical Example 4, Shoreline Position Variation with Time at Locations Indicated and Shown in Figure F-1.

OUTPUT FILE: DNRBS.INP
(Example No. 4)

```
   EXAMPLE NO. 4 NO  BACK. EROS. NO STRUC. 3500 FT. PROJ.
   2.00      6.0     90.0     90.0    180.0    500.0 86400.0
   17.0      6.0     0.77     1.0       0.0     90    180 10950       0
    0.0      0.0  90000.      0.0 100000.      0.0  49500.       3.0
 90000.      3.0 100000.      2.0 140000.      2.0
   87     93
   87    112.0
   88    112.0
   89    112.0
   90    112.0
   91    112.0
   92    112.0
   93    112.0
```

OUTPUT FILE: DNRBS.OUT
(Example No. 4)

```
   EXAMPLE NO. 4 NO  BACK. EROS. NO STRUC. 3500 FT. PROJ.

 HO =  2.00 FT., T =  6.00 SEC.,  ALPO =  90.00 DEG., BTAO =  90.00 DEG.,
XMU =  180.00 DEG., DX =   500.00 FT., DT = 86400.00 SEC.
 HSTR =    17.00 FT., B =    6.00 FT., XK =      .77 VFACT =     1.00
    QBKREF =       .00 FT.**3/SEC.
   IREF =      90, IMAX =     180, NTIMES =    10950, NS =      0



 .00E+00     .00 .90E+05     .00 .10E+06     .00 .50E+05    3.00
 .90E+05    3.00 .10E+06    2.00 .14E+06    2.00
```

BACKGROUND EROSION TRANSPORT RATES

1	.000	2	.000	3	.000	4	.000	5	.000
6	.000	7	.000	8	.000	9	.000	10	.000
11	.000	12	.000	13	.000	14	.000	15	.000
16	.000	17	.000	18	.000	19	.000	20	.000
21	.000	22	.000	23	.000	24	.000	25	.000
26	.000	27	.000	28	.000	29	.000	30	.000
31	.000	32	.000	33	.000	34	.000	35	.000
36	.000	37	.000	38	.000	39	.000	40	.000
41	.000	42	.000	43	.000	44	.000	45	.000
46	.000	47	.000	48	.000	49	.000	50	.000
51	.000	52	.000	53	.000	54	.000	55	.000
56	.000	57	.000	58	.000	59	.000	60	.000
61	.000	62	.000	63	.000	64	.000	65	.000
66	.000	67	.000	68	.000	69	.000	70	.000
71	.000	72	.000	73	.000	74	.000	75	.000
76	.000	77	.000	78	.000	79	.000	80	.000
81	.000	82	.000	83	.000	84	.000	85	.000
86	.000	87	.000	88	.000	89	.000	90	.000
91	.000	92	.000	93	.000	94	.000	95	.000
96	.000	97	.000	98	.000	99	.000	100	.000
101	.000	102	.000	103	.000	104	.000	105	.000
106	.000	107	.000	108	.000	109	.000	110	.000
111	.000	112	.000	113	.000	114	.000	115	.000
116	.000	117	.000	118	.000	119	.000	120	.000
121	.000	122	.000	123	.000	124	.000	125	.000
126	.000	127	.000	128	.000	129	.000	130	.000
131	.000	132	.000	133	.000	134	.000	135	.000
136	.000	137	.000	138	.000	139	.000	140	.000
141	.000	142	.000	143	.000	144	.000	145	.000
146	.000	147	.000	148	.000	149	.000	150	.000
151	.000	152	.000	153	.000	154	.000	155	.000
156	.000	157	.000	158	.000	159	.000	160	.000
161	.000	162	.000	163	.000	164	.000	165	.000
166	.000	167	.000	168	.000	169	.000	170	.000
171	.000	172	.000	173	.000	174	.000	175	.000
176	.000	177	.000	178	.000	179	.000	180	.000
181	.000								

87 93
INITIAL SHORELINE (INCL. NOURISHMENT) POSITION

1	0.	.00	2	500.	.00
3	1000.	.00	4	1500.	.00
5	2000.	.00	6	2500.	.00
7	3000.	.00	8	3500.	.00
9	4000.	.00	10	4500.	.00
11	5000.	.00	12	5500.	.00
13	6000.	.00	14	6500.	.00
15	7000.	.00	16	7500.	.00
17	8000.	.00	18	8500.	.00
19	9000.	.00	20	9500.	.00
21	10000.	.00	22	10500.	.00
23	11000.	.00	24	11500.	.00
25	12000.	.00	26	12500.	.00
27	13000.	.00	28	13500.	.00
29	14000.	.00	30	14500.	.00
31	15000.	.00	32	15500.	.00
33	16000.	.00	34	16500.	.00
35	17000.	.00	36	17500.	.00
37	18000.	.00	38	18500.	.00
39	19000.	.00	40	19500.	.00
41	20000.	.00	42	20500.	.00
43	21000.	.00	44	21500.	.00
45	22000.	.00	46	22500.	.00
47	23000.	.00	48	23500.	.00
49	24000.	.00	50	24500.	.00
51	25000.	.00	52	25500.	.00
53	26000.	.00	54	26500.	.00
55	27000.	.00	56	27500.	.00
57	28000.	.00	58	28500.	.00
59	29000.	.00	60	29500.	.00
61	30000.	.00	62	30500.	.00
63	31000.	.00	64	31500.	.00
65	32000.	.00	66	32500.	.00
67	33000.	.00	68	33500.	.00
69	34000.	.00	70	34500.	.00
71	35000.	.00	72	35500.	.00
73	36000.	.00	74	36500.	.00
75	37000.	.00	76	37500.	.00
77	38000.	.00	78	38500.	.00
79	39000.	.00	80	39500.	.00
81	40000.	.00	82	40500.	.00
83	41000.	.00	84	41500.	.00
85	42000.	.00	86	42500.	.00
87	43000.	112.00	88	43500.	112.00
89	44000.	112.00	90	44500.	112.00
91	45000.	112.00	92	45500.	112.00
93	46000.	112.00	94	46500.	.00
95	47000.	.00	96	47500.	.00
97	48000.	.00	98	48500.	.00
99	49000.	.00	100	49500.	.00
101	50000.	.00	102	50500.	.00
103	51000.	.00	104	51500.	.00
105	52000.	.00	106	52500.	.00
107	53000.	.00	108	53500.	.00
109	54000.	.00	110	54500.	.00
111	55000.	.00	112	55500.	.00
113	56000.	.00	114	56500.	.00
115	57000.	.00	116	[illegible]0.	.00
117	58000.	.00	118	120 [illegible]0.	.00
119	59000.	.00	120	[illegible]0.	.00
121	60000.	.00	122	60500.	.00
123	61000.	.00	124	61500.	.00

```
  125    62000.      .00   126    62500.      .00
  127    63000.      .00   128    63500.      .00
  129    64000.      .00   130    64500.      .00
  131    65000.      .00   132    65500.      .00
  133    66000.      .00   134    66500.      .00
  135    67000.      .00   136    67500.      .00
  137    68000.      .00   138    68500.      .00
  139    69000.      .00   140    69500.      .00
  141    70000.      .00   142    70500.      .00
  143    71000.      .00   144    71500.      .00
  145    72000.      .00   146    72500.      .00
  147    73000.      .00   148    73500.      .00
  149    74000.      .00   150    74500.      .00
  151    75000.      .00   152    75500.      .00
  153    76000.      .00   154    76500.      .00
  155    77000.      .00   156    77500.      .00
  157    78000.      .00   158    78500.      .00
  159    79000.      .00   160    79500.      .00
  161    80000.      .00   162    80500.      .00
  163    81000.      .00   164    81500.      .00
  165    82000.      .00   166    82500.      .00
  167    83000.      .00   168    83500.      .00
  169    84000.      .00   170    84500.      .00
  171    85000.      .00   172    85500.      .00
  173    86000.      .00   174    86500.      .00
  175    87000.      .00   176    87500.      .00
  177    88000.      .00   178    88500.      .00
  179    89000.      .00   180    89500.      .00
  100    116     .000     .000     .000     .000     .000     .000     .000
                 TIME =          1  YEARS
    1      .00    2      .00    3      .00    4      .00    5      .00    6      .00
    7      .00    8      .00    9      .00   10      .00   11      .00   12      .00
   13      .00   14      .00   15      .00   16      .00   17      .00   18      .00
   19      .00   20      .00   21      .00   22      .00   23      .00   24      .00
   25      .00   26      .00   27      .00   28      .00   29      .00   30      .00
   31      .00   32      .00   33      .00   34      .00   35      .00   36      .00
   37      .00   38      .00   39      .00   40      .00   41      .00   42      .00
   43      .00   44      .00   45      .00   46      .00   47      .00   48      .00
   49      .00   50      .00   51      .00   52      .00   53      .00   54      .00
   55      .00   56      .00   57      .00   58      .00   59      .00   60      .00
   61      .00   62      .00   63      .00   64      .00   65      .00   66      .01
   67      .02   68      .04   69      .07   70      .13   71      .23   72      .40
   73      .68   74     1.12   75     1.79   76     2.77   77     4.18   78     6.11
   79     8.67   80    11.93   81    15.93   82    20.62   83    25.90   84    31.56
   85    37.30   86    42.76   87    47.55   88    51.30   89    53.69   90    54.51
   91    53.69   92    51.30   93    47.55   94    42.76   95    37.30   96    31.56
   97    25.90   98    20.62   99    15.93  100    11.93  101     8.67  102     6.11
  103     4.18  104     2.77  105     1.79  106     1.12  107      .68  108      .40
  109      .23  110      .13  111      .07  112      .04  113      .02  114      .01
  115      .00  116      .00  117      .00  118      .00  119      .00  120      .00
  121      .00  122      .00  123      .00  124      .00  125      .00  126      .00
  127      .00  128      .00  129      .00  130      .00  131      .00  132      .00
  133      .00  134      .00  135      .00  136      .00  137      .00  138      .00
  139      .00  140      .00  141      .00  142      .00  143      .00  144      .00
  145      .00  146      .00  147      .00  148      .00  149      .00  150      .00
  151      .00  152      .00  153      .00  154      .00  155      .00  156      .00
  157      .00  158      .00  159      .00  160      .00  161      .00  162      .00
  163      .00  164      .00  165      .00  166      .00  167      .00  168      .00
  169      .00  170      .00  171      .00  172      .00  173      .00  174      .00
  175      .00  176      .00  177      .00  178      .00  179      .00  180      .00
      LCUR =         1  PCT(LCUR) =        .46
      LCUR =         2  PCT(LCUR) =        [illegible]
      LCUR =         3  PCT(LCUR) =          121
      LCUR =         4  PCT(LCUR) =
                        TIME =          5  YEARS
    1      .00    2      .00    3      .00    4      .00    5      .00    6      .00
```

7	.00	8	.00	9	.00	10	.00	11	.00	12	.00
13	.00	14	.00	15	.00	16	.00	17	.00	18	.00
19	.00	20	.00	21	.00	22	.00	23	.00	24	.00
25	.00	26	.00	27	.00	28	.00	29	.00	30	.00
31	.00	32	.00	33	.00	34	.00	35	.00	36	.00
37	.00	38	.00	39	.00	40	.01	41	.01	42	.01
43	.02	44	.02	45	.03	46	.04	47	.05	48	.07
49	.09	50	.12	51	.16	52	.20	53	.26	54	.33
55	.42	56	.53	57	.66	58	.82	59	1.01	60	1.24
61	1.52	62	1.84	63	2.21	64	2.64	65	3.13	66	3.69
67	4.33	68	5.03	69	5.82	70	6.67	71	7.61	72	8.62
73	9.70	74	10.84	75	12.03	76	13.26	77	14.52	78	15.80
79	17.07	80	18.32	81	19.53	82	20.69	83	21.76	84	22.73
85	23.59	86	24.32	87	24.90	88	25.32	89	25.58	90	25.66
91	25.58	92	25.32	93	24.90	94	24.32	95	23.59	96	22.73
97	21.76	98	20.69	99	19.53	100	18.32	101	17.07	102	15.80
103	14.52	104	13.26	105	12.03	106	10.84	107	9.70	108	8.62
109	7.61	110	6.67	111	5.82	112	5.03	113	4.33	114	3.69
115	3.13	116	2.64	117	2.21	118	1.84	119	1.52	120	1.24
121	1.01	122	.82	123	.66	124	.53	125	.42	126	.33
127	.26	128	.20	129	.16	130	.12	131	.09	132	.07
133	.05	134	.04	135	.03	136	.02	137	.02	138	.01
139	.01	140	.01	141	.00	142	.00	143	.00	144	.00
145	.00	146	.00	147	.00	148	.00	149	.00	150	.00
151	.00	152	.00	153	.00	154	.00	155	.00	156	.00
157	.00	158	.00	159	.00	160	.00	161	.00	162	.00
163	.00	164	.00	165	.00	166	.00	167	.00	168	.00
169	.00	170	.00	171	.00	172	.00	173	.00	174	.00
175	.00	176	.00	177	.00	178	.00	179	.00	180	.00

LCUR = 5 PCT(LCUR) = .23
LCUR = 6 PCT(LCUR) = .21
LCUR = 7 PCT(LCUR) = .19
LCUR = 8 PCT(LCUR) = .18
LCUR = 9 PCT(LCUR) = .17
TIME = 10 YEARS

1	.00	2	.00	3	.00	4	.00	5	.00	6	.00
7	.00	8	.00	9	.00	10	.00	11	.00	12	.00
13	.00	14	.00	15	.00	16	.00	17	.00	18	.00
19	.00	20	.00	21	.01	22	.01	23	.01	24	.01
25	.01	26	.02	27	.02	28	.03	29	.03	30	.04
31	.05	32	.06	33	.07	34	.09	35	.11	36	.13
37	.15	38	.18	39	.22	40	.26	41	.31	42	.36
43	.42	44	.50	45	.58	46	.67	47	.78	48	.90
49	1.04	50	1.19	51	1.37	52	1.56	53	1.77	54	2.00
55	2.26	56	2.54	57	2.85	58	3.19	59	3.55	60	3.94
61	4.35	62	4.80	63	5.27	64	5.77	65	6.29	66	6.84
67	7.41	68	8.00	69	8.61	70	9.23	71	9.87	72	10.51
73	11.16	74	11.80	75	12.44	76	13.07	77	13.69	78	14.29
79	14.86	80	15.40	81	15.91	82	16.38	83	16.80	84	17.18
85	17.50	86	17.77	87	17.99	88	18.14	89	18.24	90	18.27
91	18.24	92	18.14	93	17.99	94	17.77	95	17.50	96	17.18
97	16.80	98	16.38	99	15.91	100	15.40	101	14.86	102	14.29
103	13.69	104	13.07	105	12.44	106	11.80	107	11.16	108	10.51
109	9.87	110	9.23	111	8.61	112	8.00	113	7.41	114	6.84
115	6.29	116	5.77	117	5.27	118	4.80	119	4.35	120	3.94
121	3.55	122	3.19	123	2.85	124	2.54	125	2.26	126	2.00
127	1.77	128	1.56	129	1.37	130	1.19	131	1.04	132	.90
133	.78	134	.67	135	.58	136	.50	137	.42	138	.36
139	.31	140	.26	141	.22	142	.18	143	.15	144	.13
145	.11	146	.09	147	.07	148	.06	149	.05	150	.04
151	.03	152	.03	153	.02		.02	155	.01	156	.01
157	.01	158	.01	159	.01		.00	161	.00	162	.00
163	.00	164	.00	165	.00	[illegible]	.00	167	.00	168	.00
169	.00	170	.00	171	.00	172	.00	173	.00	174	.00
175	.00	176	.00	177	.00	178	.00	179	.00	180	.00

LCUR = 10 PCT(LCUR) = .16

```
LCUR =      11  PCT(LCUR) =       .15
LCUR =      12  PCT(LCUR) =       .15
LCUR =      13  PCT(LCUR) =       .14
LCUR =      14  PCT(LCUR) =       .14
LCUR =      15  PCT(LCUR) =       .13
LCUR =      16  PCT(LCUR) =       .13
LCUR =      17  PCT(LCUR) =       .12
LCUR =      18  PCT(LCUR) =       .12
LCUR =      19  PCT(LCUR) =       .12
LCUR =      20  PCT(LCUR) =       .12
LCUR =      21  PCT(LCUR) =       .11
LCUR =      22  PCT(LCUR) =       .11
LCUR =      23  PCT(LCUR) =       .11
LCUR =      24  PCT(LCUR) =       .11
LCUR =      25  PCT(LCUR) =       .10
LCUR =      26  PCT(LCUR) =       .10
LCUR =      27  PCT(LCUR) =       .10
LCUR =      28  PCT(LCUR) =       .10
LCUR =      29  PCT(LCUR) =       .10
                TIME =       30  YEARS
```

1	.00	2	.02	3	.05	4	.07	5	.09	6	.12
7	.14	8	.17	9	.20	10	.23	11	.26	12	.29
13	.32	14	.36	15	.40	16	.44	17	.48	18	.53
19	.57	20	.62	21	.68	22	.74	23	.80	24	.86
25	.93	26	1.01	27	1.08	28	1.16	29	1.25	30	1.34
31	1.44	32	1.54	33	1.64	34	1.75	35	1.87	36	1.99
37	2.11	38	2.25	39	2.38	40	2.52	41	2.67	42	2.83
43	2.98	44	3.15	45	3.32	46	3.49	47	3.67	48	3.85
49	4.04	50	4.23	51	4.43	52	4.63	53	4.83	54	5.04
55	5.25	56	5.46	57	5.67	58	5.89	59	6.10	60	6.32
61	6.54	62	6.76	63	6.97	64	7.19	65	7.40	66	7.61
67	7.82	68	8.02	69	8.23	70	8.42	71	8.61	72	8.80
73	8.97	74	9.15	75	9.31	76	9.47	77	9.61	78	9.75
79	9.88	80	10.00	81	10.11	82	10.21	83	10.30	84	10.38
85	10.44	86	10.50	87	10.54	88	10.57	89	10.59	90	10.59
91	10.59	92	10.57	93	10.54	94	10.50	95	10.44	96	10.38
97	10.30	98	10.21	99	10.11	100	10.00	101	9.88	102	9.75
103	9.61	104	9.47	105	9.31	106	9.15	107	8.97	108	8.80
109	8.61	110	8.42	111	8.23	112	8.02	113	7.82	114	7.61
115	7.40	116	7.19	117	6.97	118	6.76	119	6.54	120	6.32
121	6.10	122	5.89	123	5.67	124	5.46	125	5.25	126	5.04
127	4.83	128	4.63	129	4.43	130	4.23	131	4.04	132	3.85
133	3.67	134	3.49	135	3.32	136	3.15	137	2.98	138	2.83
139	2.67	140	2.52	141	2.38	142	2.25	143	2.11	144	1.99
145	1.87	146	1.75	147	1.64	148	1.54	149	1.44	150	1.34
151	1.25	152	1.17	153	1.08	154	1.01	155	.93	156	.87
157	.80	158	.74	159	.68	160	.63	161	.58	162	.53
163	.48	164	.44	165	.40	166	.36	167	.33	168	.30
169	.27	170	.24	171	.21	172	.18	173	.16	174	.13
175	.11	176	.09	177	.06	178	.04	179	.02	180	.00

```
LCUR =      30  PCT(LCUR) =       .09
```

APPENDIX G

NUMERICAL EXAMPLE 5

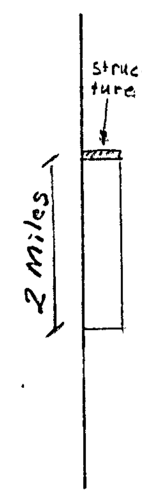
BEACH NOURISHMENT PROJECTION
(Numerical Procedure)

General Location: *Example 5*

Wave Height, H_0 (Fig. 22):	2.0 ft.,	Closure Depth, h_* (Fig. 8):	17 ft.
Wave Period, T (Fig. 23):	6 sec.,	Berm Height, B:	6 ft.
Wave Direction, α_0:	90 °,	Sand Diameter, D:	0.35 mm
Deep Water Contour Orientation, β_0:	90 °,	Transport Factor, K (Fig. 5):	0.77
Longshore Axis Orientation, μ:	180 °,	VFACT:	1.0
Grid Dimension, Δx:	500 ft	Background Transport, QREF:	0 ft^3/s
Time Increment, Δt:	86400 sec	IREF:	90
		IMAX:	180
		NTIMES:	10950
		No. of Structures, NS:	1

Structure Specificiation / **Background Erosion**

Structure Number	Structure Location, I	Structure Length (ft)	x	Erosion Rate, ER, (ft/yr)
1	80	112.0	0.0	0.0
2			90,000	0.0
3				
4				
5				
6				



Equilibrated Beach Width Δy_0

A_N (Fig. 7) or From Profile:	ft$^{1/3}$
A_F (Fig. 7):	ft$^{1/3}$
Volume Per Unit Length:	ft^3/ft
Δy_0 (Figs. 11 and 12):	112 ft

Nourishment Specification

I Range			Δy_0
80	to	100	112.0
	to		
	to		
	to		
	to		

No Background Erosion

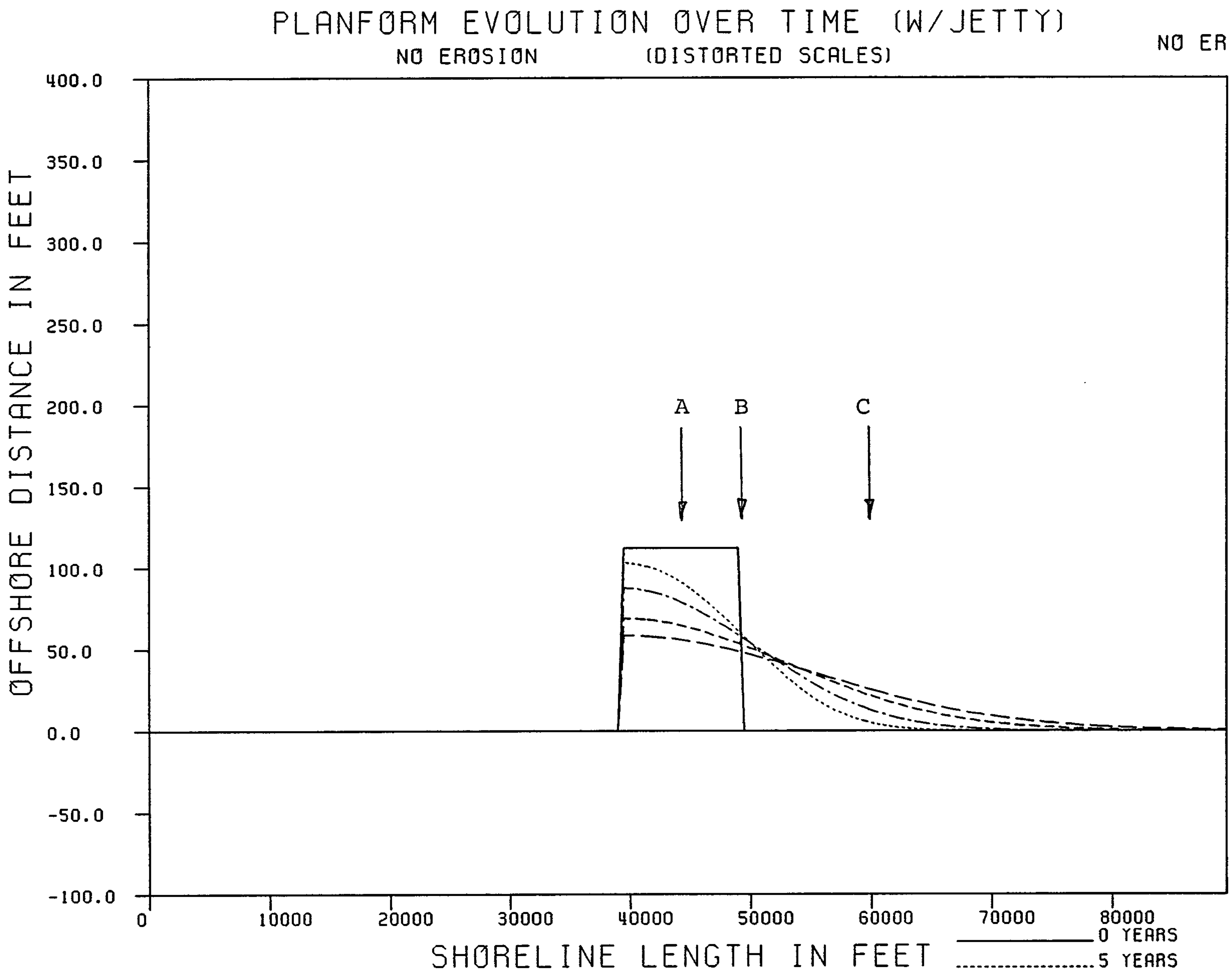


Figure G-1. Numerical Example 5, 112 ft Long Structure at North End of Project, Nourishment Length = 2 Miles, No Background Erosion.

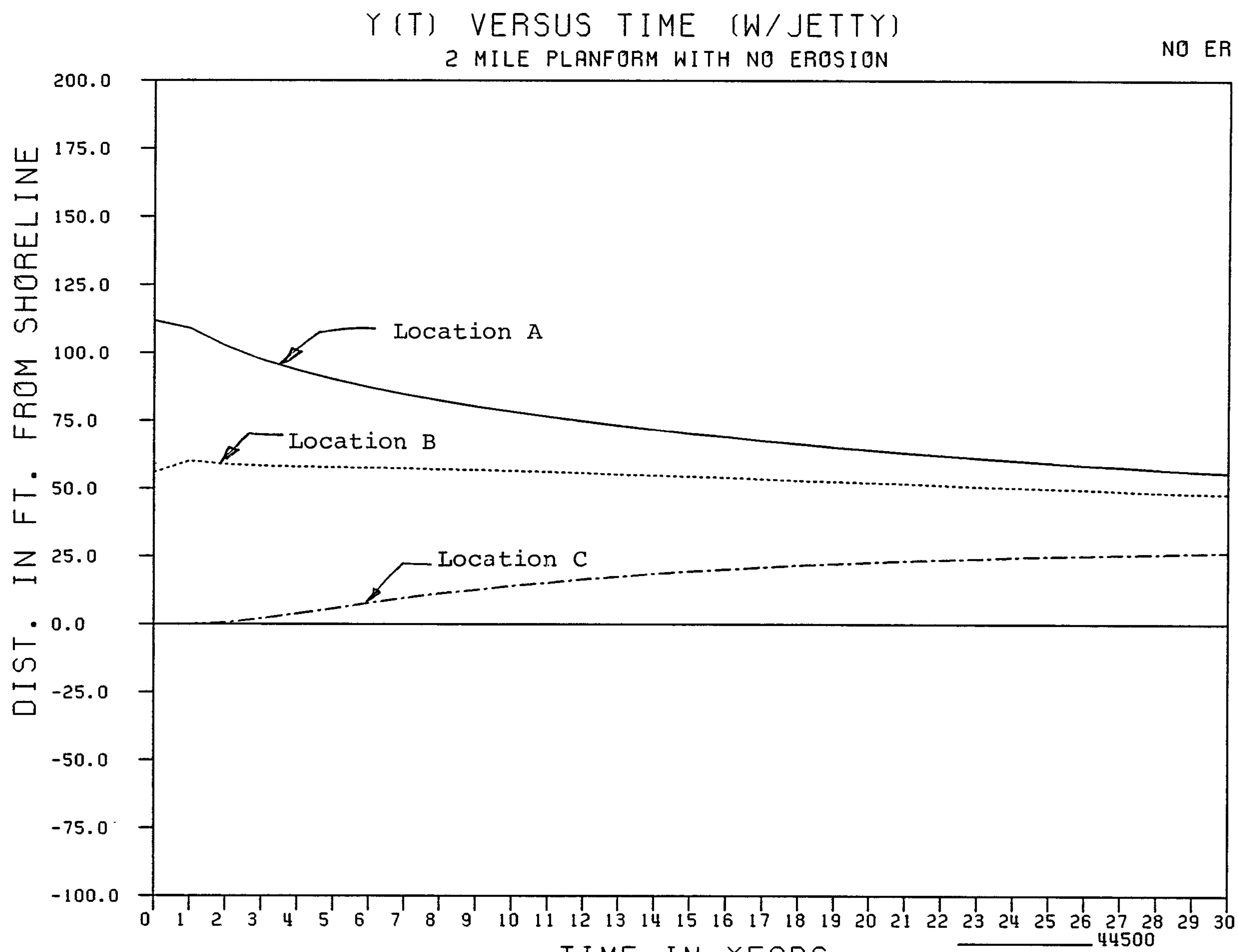


Figure G-2. Numerical Example 5, Shoreline Position Variation with Time at Locations Indicated and Shown in Figure G-1.

INPUT FILE: DNRBS.INP
(Example No. 5)

```
   EXAMPLE NO. 5 NO  BACK. EROS. ONE STRUC.
   2.00      6.0    90.0    90.0   180.0   500.0 86400.0
   17.0      6.0    0.77     1.0     0.0    90   180 10950      1
   80   112.0
    0.0      0.0  90000.     0.0 100000.    0.0  49500.      3.0
 90000.      3.0 100000.     2.0 140000.    2.0
   80   100
   80   112.0
   81   112.0
   82   112.0
   83   112.0
   84   112.0
   85   112.0
   86   112.0
   87   112.0
   88   112.0
   89   112.0
   90   112.0
   91   112.0
   92   112.0
   93   112.0
   94   112.0
   95   112.0
   96   112.0
   97   112.0
   98   112.0
   99   112.0
  100   112.0
```

OUTPUT FILE: DNRBS.OUT
(Example No. 5)

```
EXAMPLE NO. 5 NO  BACK. EROS. ONE STRUC.

 HO =  2.00 FT., T =  6.00 SEC.,  ALPO =  90.00 DEG., BTAO =  90.00 DEG.,
XMU =  180.00 DEG., DX =   500.00 FT., DT = 86400.00 SEC.
 HSTR =     17.00 FT., B =      6.00 FT., XK =      .77 VFACT =      1.00
    QBKREF =       .00 FT.**3/SEC.
   IREF =      90, IMAX =     180, NTIMES =    10950, NS =      1


    80 112.000


 .00E+00     .00 .90E+05     .00 .10E+06     .00 .50E+05    3.00
 .90E+05    3.00 .10E+06    2.00 .14E+06    2.00
```

BACKGROUND EROSION TRANSPORT RATES

1	.000	2	.000	3	.000	4	.000	5	.000
6	.000	7	.000	8	.000	9	.000	10	.000
11	.000	12	.000	13	.000	14	.000	15	.000
16	.000	17	.000	18	.000	19	.000	20	.000
21	.000	22	.000	23	.000	24	.000	25	.000
26	.000	27	.000	28	.000	29	.000	30	.000
31	.000	32	.000	33	.000	34	.000	35	.000
36	.000	37	.000	38	.000	39	.000	40	.000
41	.000	42	.000	43	.000	44	.000	45	.000
46	.000	47	.000	48	.000	49	.000	50	.000
51	.000	52	.000	53	.000	54	.000	55	.000
56	.000	57	.000	58	.000	59	.000	60	.000
61	.000	62	.000	63	.000	64	.000	65	.000
66	.000	67	.000	68	.000	69	.000	70	.000
71	.000	72	.000	73	.000	74	.000	75	.000
76	.000	77	.000	78	.000	79	.000	80	.000
81	.000	82	.000	83	.000	84	.000	85	.000
86	.000	87	.000	88	.000	89	.000	90	.000
91	.000	92	.000	93	.000	94	.000	95	.000
96	.000	97	.000	98	.000	99	.000	100	.000
101	.000	102	.000	103	.000	104	.000	105	.000
106	.000	107	.000	108	.000	109	.000	110	.000
111	.000	112	.000	113	.000	114	.000	115	.000
116	.000	117	.000	118	.000	119	.000	120	.000
121	.000	122	.000	123	.000	124	.000	125	.000
126	.000	127	.000	128	.000	129	.000	130	.000
131	.000	132	.000	133	.000	134	.000	135	.000
136	.000	137	.000	138	.000	139	.000	140	.000
141	.000	142	.000	143	.000	144	.000	145	.000
146	.000	147	.000	148	.000	149	.000	150	.000
151	.000	152	.000	153	.000	154	.000	155	.000
156	.000	157	.000	158	.000	159	.000	160	.000
161	.000	162	.000	163	129 0	164	.000	165	.000
166	.000	167	.000	168	0	169	.000	170	.000
171	.000	172	.000	173	0	174	.000	175	.000
176	.000	177	.000	178	.000	179	.000	180	.000
181	.000								

80 100

INITIAL SHORELINE (INCL. NOURISHMENT) POSITION

1	0.	.00	2	500.	.00
3	1000.	.00	4	1500.	.00
5	2000.	.00	6	2500.	.00
7	3000.	.00	8	3500.	.00
9	4000.	.00	10	4500.	.00
11	5000.	.00	12	5500.	.00
13	6000.	.00	14	6500.	.00
15	7000.	.00	16	7500.	.00
17	8000.	.00	18	8500.	.00
19	9000.	.00	20	9500.	.00
21	10000.	.00	22	10500.	.00
23	11000.	.00	24	11500.	.00
25	12000.	.00	26	12500.	.00
27	13000.	.00	28	13500.	.00
29	14000.	.00	30	14500.	.00
31	15000.	.00	32	15500.	.00
33	16000.	.00	34	16500.	.00
35	17000.	.00	36	17500.	.00
37	18000.	.00	38	18500.	.00
39	19000.	.00	40	19500.	.00
41	20000.	.00	42	20500.	.00
43	21000.	.00	44	21500.	.00
45	22000.	.00	46	22500.	.00
47	23000.	.00	48	23500.	.00
49	24000.	.00	50	24500.	.00
51	25000.	.00	52	25500.	.00
53	26000.	.00	54	26500.	.00
55	27000.	.00	56	27500.	.00
57	28000.	.00	58	28500.	.00
59	29000.	.00	60	29500.	.00
61	30000.	.00	62	30500.	.00
63	31000.	.00	64	31500.	.00
65	32000.	.00	66	32500.	.00
67	33000.	.00	68	33500.	.00
69	34000.	.00	70	34500.	.00
71	35000.	.00	72	35500.	.00
73	36000.	.00	74	36500.	.00
75	37000.	.00	76	37500.	.00
77	38000.	.00	78	38500.	.00
79	39000.	.00	80	39500.	112.00
81	40000.	112.00	82	40500.	112.00
83	41000.	112.00	84	41500.	112.00
85	42000.	112.00	86	42500.	112.00
87	43000.	112.00	88	43500.	112.00
89	44000.	112.00	90	44500.	112.00
91	45000.	112.00	92	45500.	112.00
93	46000.	112.00	94	46500.	112.00
95	47000.	112.00	96	47500.	112.00
97	48000.	112.00	98	48500.	112.00
99	49000.	112.00	100	49500.	112.00
101	50000.	.00	102	50500.	.00
103	51000.	.00	104	51500.	.00
105	52000.	.00	106	52500.	.00
107	53000.	.00	108	53500.	.00
109	54000.	.00	110	54500.	.00
111	55000.	.00	112	55500.	.00
113	56000.	.00	114	130	.00
115	57000.	.00	116		.00
117	58000.	.00	118		.00
119	59000.	.00	120	59500.	.00
121	60000.	.00	122	60500.	.00

```
   123    61000.       .00   124    61500.       .00
   125    62000.       .00   126    62500.       .00
   127    63000.       .00   128    63500.       .00
   129    64000.       .00   130    64500.       .00
   131    65000.       .00   132    65500.       .00
   133    66000.       .00   134    66500.       .00
   135    67000.       .00   136    67500.       .00
   137    68000.       .00   138    68500.       .00
   139    69000.       .00   140    69500.       .00
   141    70000.       .00   142    70500.       .00
   143    71000.       .00   144    71500.       .00
   145    72000.       .00   146    72500.       .00
   147    73000.       .00   148    73500.       .00
   149    74000.       .00   150    74500.       .00
   151    75000.       .00   152    75500.       .00
   153    76000.       .00   154    76500.       .00
   155    77000.       .00   156    77500.       .00
   157    78000.       .00   158    78500.       .00
   159    79000.       .00   160    79500.       .00
   161    80000.       .00   162    80500.       .00
   163    81000.       .00   164    81500.       .00
   165    82000.       .00   166    82500.       .00
   167    83000.       .00   168    83500.       .00
   169    84000.       .00   170    84500.       .00
   171    85000.       .00   172    85500.       .00
   173    86000.       .00   174    86500.       .00
   175    87000.       .00   176    87500.       .00
   177    88000.       .00   178    88500.       .00
   179    89000.       .00   180    89500.       .00
   100   116     .000     .000 112.000     .000     .000     .000     .000
                    TIME =         1  YEARS
    1      .00    2      .00    3      .00    4      .00    5      .00    6      .00
    7      .00    8      .00    9      .00   10      .00   11      .00   12      .00
   13      .00   14      .00   15      .00   16      .00   17      .00   18      .00
   19      .00   20      .00   21      .00   22      .00   23      .00   24      .00
   25      .00   26      .00   27      .00   28      .00   29      .00   30      .00
   31      .00   32      .00   33      .00   34      .00   35      .00   36      .00
   37      .00   38      .00   39      .00   40      .00   41      .00   42      .00
   43      .00   44      .00   45      .00   46      .00   47      .00   48      .00
   49      .00   50      .00   51      .00   52      .00   53      .00   54      .00
   55      .00   56      .00   57      .00   58      .00   59      .00   60      .00
   61      .00   62      .00   63      .00   64      .00   65      .00   66      .00
   67      .00   68      .00   69      .00   70      .00   71      .00   72      .00
   73      .00   74      .00   75      .00   76      .00   77      .00   78      .00
   79      .00   80   111.99   81   111.98   82   111.96   83   111.93   84   111.87
   85   111.77   86   111.60   87   111.31   88   110.87   89   110.18   90   109.16
   91   107.69   92   105.66   93   102.93   94    99.38   95    94.94   96    89.55
   97    83.25   98    76.13   99    68.36  100    60.17  101    51.83  102    43.64
  103    35.87  104    28.75  105    22.45  106    17.06  107    12.62  108     9.07
  109     6.34  110     4.31  111     2.84  112     1.82  113     1.13  114      .69
  115      .40  116      .23  117      .13  118      .07  119      .04  120      .02
  121      .01  122      .00  123      .00  124      .00  125      .00  126      .00
  127      .00  128      .00  129      .00  130      .00  131      .00  132      .00
  133      .00  134      .00  135      .00  136      .00  137      .00  138      .00
  139      .00  140      .00  141      .00  142      .00  143      .00  144      .00
  145      .00  146      .00  147      .00  148      .00  149      .00  150      .00
  151      .00  152      .00  153      .00  154      .00  155      .00  156      .00
  157      .00  158      .00  159      .00  160      .00  161      .00  162      .00
  163      .00  164      .00  165      .00  166      .00  167      .00  168      .00
  169      .00  170      .00  171      .00  172      .00  173      .00  174      .00
  175      .00  176      .00  177      .00  178      .00  179      .00  180      .00
      LCUR =        1  PCT(LCUR) =
      LCUR =        2  PCT(LCUR) =
      LCUR =        3  PCT(LCUR) =
      LCUR =        4  PCT(LCUR) =
                    TIME =         5  YEARS
```

1	.00	2	.00	3	.00	4	.00	5	.00	6	.00
7	.00	8	.00	9	.00	10	.00	11	.00	12	.00
13	.00	14	.00	15	.00	16	.00	17	.00	18	.00
19	.00	20	.00	21	.00	22	.00	23	.00	24	.00
25	.00	26	.00	27	.00	28	.00	29	.00	30	.00
31	.00	32	.00	33	.00	34	.00	35	.00	36	.00
37	.00	38	.00	39	.00	40	.00	41	.00	42	.00
43	.00	44	.00	45	.00	46	.00	47	.00	48	.00
49	.00	50	.00	51	.00	52	.00	53	.00	54	.00
55	.00	56	.00	57	.00	58	.00	59	.00	60	.00
61	.00	62	.00	63	.00	64	.00	65	.00	66	.00
67	.00	68	.00	69	.00	70	.00	71	.00	72	.00
73	.00	74	.00	75	.00	76	.00	77	.00	78	.00
79	.00	80	102.93	81	102.69	82	102.22	83	101.52	84	100.58
85	99.41	86	98.00	87	96.36	88	94.50	89	92.41	90	90.10
91	87.57	92	84.85	93	81.94	94	78.86	95	75.62	96	72.25
97	68.75	98	65.17	99	61.52	100	57.83	101	54.12	102	50.42
103	46.76	104	43.16	105	39.64	106	36.24	107	32.96	108	29.82
109	26.84	110	24.04	111	21.41	112	18.96	113	16.71	114	14.64
115	12.75	116	11.05	117	9.51	118	8.15	119	6.94	120	5.87
121	4.94	122	4.13	123	3.44	124	2.84	125	2.33	126	1.90
127	1.55	128	1.25	129	1.00	130	.80	131	.63	132	.50
133	.39	134	.30	135	.23	136	.18	137	.14	138	.10
139	.08	140	.06	141	.04	142	.03	143	.02	144	.02
145	.01	146	.01	147	.01	148	.00	149	.00	150	.00
151	.00	152	.00	153	.00	154	.00	155	.00	156	.00
157	.00	158	.00	159	.00	160	.00	161	.00	162	.00
163	.00	164	.00	165	.00	166	.00	167	.00	168	.00
169	.00	170	.00	171	.00	172	.00	173	.00	174	.00
175	.00	176	.00	177	.00	178	.00	179	.00	180	.00

LCUR = 5 PCT(LCUR) = .77
LCUR = 6 PCT(LCUR) = .75
LCUR = 7 PCT(LCUR) = .73
LCUR = 8 PCT(LCUR) = .71
LCUR = 9 PCT(LCUR) = .69

TIME = 10 YEARS

1	.00	2	.00	3	.00	4	.00	5	.00	6	.00
7	.00	8	.00	9	.00	10	.00	11	.00	12	.00
13	.00	14	.00	15	.00	16	.00	17	.00	18	.00
19	.00	20	.00	21	.00	22	.00	23	.00	24	.00
25	.00	26	.00	27	.00	28	.00	29	.00	30	.00
31	.00	32	.00	33	.00	34	.00	35	.00	36	.00
37	.00	38	.00	39	.00	40	.00	41	.00	42	.00
43	.00	44	.00	45	.00	46	.00	47	.00	48	.00
49	.00	50	.00	51	.00	52	.00	53	.00	54	.00
55	.00	56	.00	57	.00	58	.00	59	.00	60	.00
61	.00	62	.00	63	.00	64	.00	65	.00	66	.00
67	.00	68	.00	69	.00	70	.00	71	.00	72	.00
73	.00	74	.00	75	.00	76	.00	77	.00	78	.00
79	.00	80	87.69	81	87.51	82	87.16	83	86.63	84	85.92
85	85.05	86	84.02	87	82.82	88	81.48	89	79.98	90	78.35
91	76.59	92	74.70	93	72.71	94	70.61	95	68.42	96	66.15
97	63.81	98	61.41	99	58.97	100	56.49	101	53.99	102	51.47
103	48.95	104	46.45	105	43.96	106	41.50	107	39.08	108	36.71
109	34.39	110	32.14	111	29.95	112	27.84	113	25.81	114	23.86
115	22.00	116	20.23	117	18.55	118	16.96	119	15.47	120	14.07
121	12.75	122	11.53	123	10.40	124	9.35	125	8.38	126	7.49
127	6.67	128	5.93	129	5.25	130	4.64	131	4.08	132	3.58
133	3.14	134	2.74	135	2.38	136	2.07	137	1.79	138	1.54
139	1.32	140	1.13	141	.97	142	.82	143	.70	144	.59
145	.50	146	.42	147	.3[illegible]	148	.29	149	.24	150	.20
151	.17	152	.14	153	.[illegible]	132	.09	155	.08	156	.06
157	.05	158	.04	159	.[illegible]	[illegible]	.03	161	.02	162	.02
163	.01	164	.01	165	.01	166	.01	167	.01	168	.00
169	.00	170	.00	171	.00	172	.00	173	.00	174	.00
175	.00	176	.00	177	.00	178	.00	179	.00	180	.00

```
LCUR =   10  PCT(LCUR) =      .68
LCUR =   11  PCT(LCUR) =      .66
LCUR =   12  PCT(LCUR) =      .65
LCUR =   13  PCT(LCUR) =      .64
LCUR =   14  PCT(LCUR) =      .62
LCUR =   15  PCT(LCUR) =      .61
LCUR =   16  PCT(LCUR) =      .60
LCUR =   17  PCT(LCUR) =      .59
LCUR =   18  PCT(LCUR) =      .58
LCUR =   19  PCT(LCUR) =      .57
LCUR =   20  PCT(LCUR) =      .56
LCUR =   21  PCT(LCUR) =      .55
LCUR =   22  PCT(LCUR) =      .54
LCUR =   23  PCT(LCUR) =      .54
LCUR =   24  PCT(LCUR) =      .53
LCUR =   25  PCT(LCUR) =      .52
LCUR =   26  PCT(LCUR) =      .51
LCUR =   27  PCT(LCUR) =      .51
LCUR =   28  PCT(LCUR) =      .50
LCUR =   29  PCT(LCUR) =      .50
             TIME =      30  YEARS
  1     .00   2     .00   3     .00   4     .00   5     .00   6     .00
  7     .00   8     .00   9     .00  10     .00  11     .00  12     .00
 13     .00  14     .00  15     .00  16     .00  17     .00  18     .00
 19     .00  20     .00  21     .00  22     .00  23     .00  24     .00
 25     .00  26     .00  27     .00  28     .00  29     .00  30     .00
 31     .00  32     .00  33     .00  34     .00  35     .00  36     .00
 37     .00  38     .00  39     .00  40     .00  41     .00  42     .00
 43     .00  44     .00  45     .00  46     .00  47     .00  48     .00
 49     .00  50     .00  51     .00  52     .00  53     .00  54     .00
 55     .00  56     .00  57     .00  58     .00  59     .00  60     .00
 61     .00  62     .00  63     .00  64     .00  65     .00  66     .00
 67     .00  68     .00  69     .00  70     .00  71     .00  72     .00
 73     .00  74     .00  75     .00  76     .00  77     .00  78     .00
 79     .00  80   58.69  81   58.63  82   58.52  83   58.35  84   58.12
 85   57.84  86   57.50  87   57.12  88   56.67  89   56.18  90   55.64
 91   55.05  92   54.41  93   53.73  94   53.00  95   52.23  96   51.43
 97   50.59  98   49.71  99   48.80 100   47.86 101   46.89 102   45.90
103   44.88 104   43.84 105   42.79 106   41.72 107   40.64 108   39.54
109   38.44 110   37.33 111   36.22 112   35.10 113   33.99 114   32.88
115   31.78 116   30.68 117   29.59 118   28.51 119   27.44 120   26.38
121   25.35 122   24.32 123   23.32 124   22.33 125   21.37 126   20.43
127   19.50 128   18.60 129   17.73 130   16.88 131   16.05 132   15.25
133   14.47 134   13.72 135   13.00 136   12.30 137   11.63 138   10.98
139   10.36 140    9.76 141    9.19 142    8.64 143    8.12 144    7.62
145    7.14 146    6.69 147    6.25 148    5.84 149    5.46 150    5.09
151    4.74 152    4.41 153    4.09 154    3.80 155    3.52 156    3.26
157    3.01 158    2.78 159    2.56 160    2.36 161    2.17 162    1.99
163    1.82 164    1.66 165    1.51 166    1.37 167    1.24 168    1.11
169    1.00 170     .88 171     .78 172     .68 173     .59 174     .49
175     .41 176     .32 177     .24 178     .16 179     .08 180     .00
LCUR =   30  PCT(LCUR) =      .49
```

APPENDIX H

NUMERICAL EXAMPLE 6

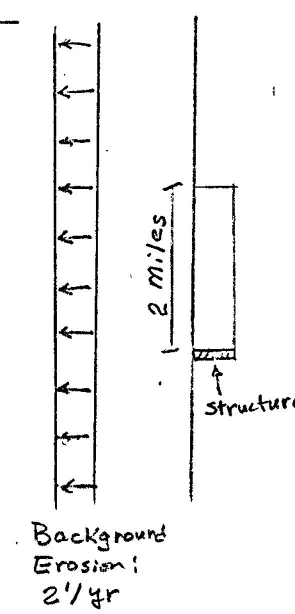
BEACH NOURISHMENT PROJECTION
(Numerical Procedure)

General Location: Example 6

Wave Height, H_0 (Fig. 22):	2.0 ft.,	Closure Depth, h_* (Fig. 8):	17 ft.
Wave Period, T (Fig. 23):	6.0 sec.,	Berm Height, B:	6 ft.
Wave Direction, α_0:	90 °,	Sand Diameter, D:	0.35 mm
Deep Water Contour Orientation, β_0:	90 °,	Transport Factor, K (Fig. 5):	0.77
Longshore Axis Orientation, μ:	180 °,	VFACT:	1.0
Grid Dimension, Δx:	500 ft	Background Transport, QREF:	0.0 ft^3/s
Time Increment, Δt:	86400 sec	IREF:	90
		IMAX:	180
		NTIMES:	10950
		No. of Structures, NS:	1

Structure Specificiation / **Background Erosion**

Structure Number	Structure Location, I	Structure Length (ft)	x	Erosion Rate, ER, (ft/yr)
1	100	112.0	0.0	2.0
2			90000	2.0
3				
4				
5				
6				



Equilibrated Beach Width Δy_0

A_N (Fig. 7) or From Profile:	____ $ft^{1/3}$
A_F (Fig. 7):	____ $ft^{1/3}$
Volume Per Unit Length:	____ ft^3/ft
Δy_0 (Figs. 11 and 12):	112.0 ft

Nourishment Specification

I Range			Δy_0
80	to	100	112.0
	to		
	to		
	to		
	to		

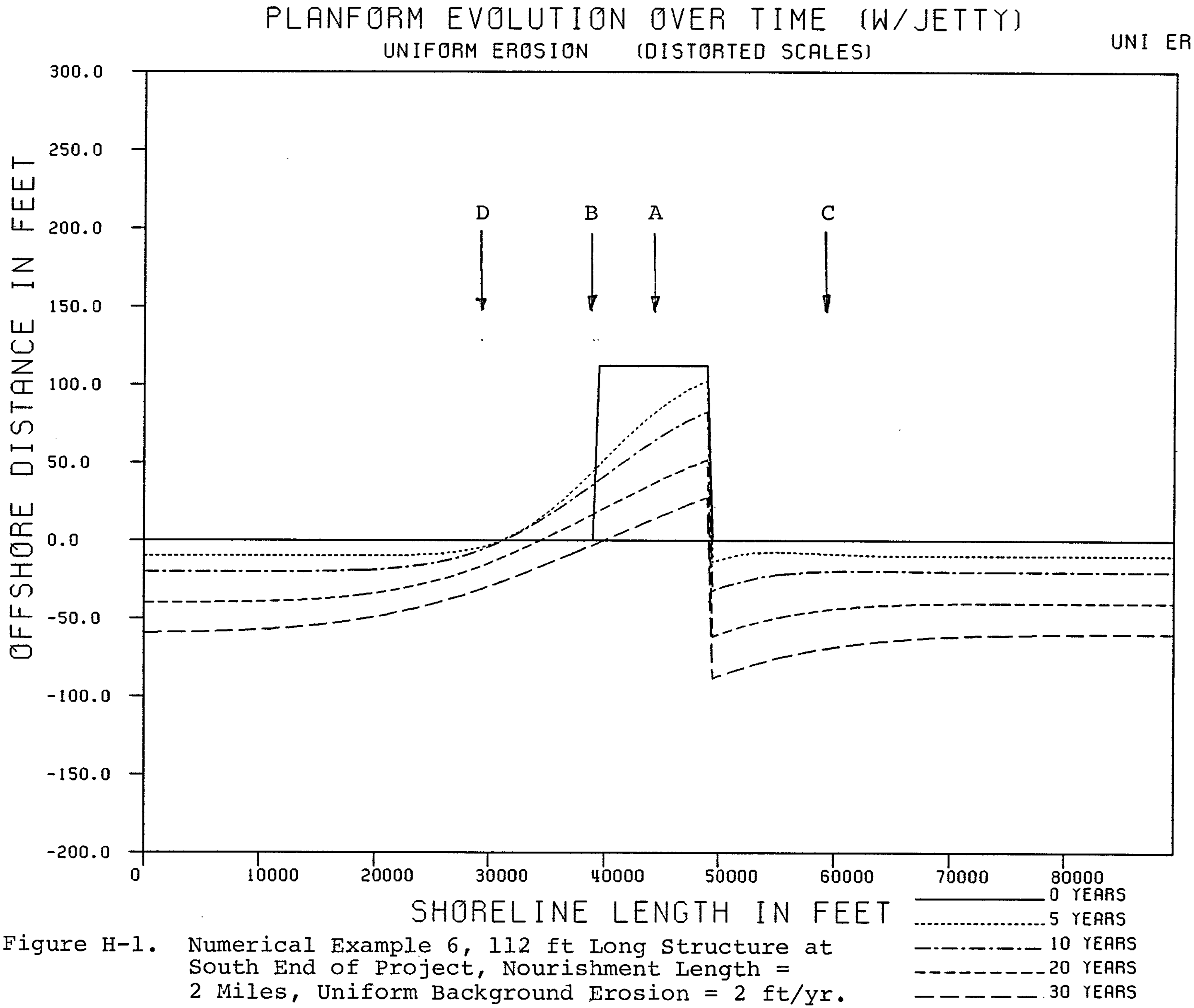


Figure H-1. Numerical Example 6, 112 ft Long Structure at South End of Project, Nourishment Length = 2 Miles, Uniform Background Erosion = 2 ft/yr.

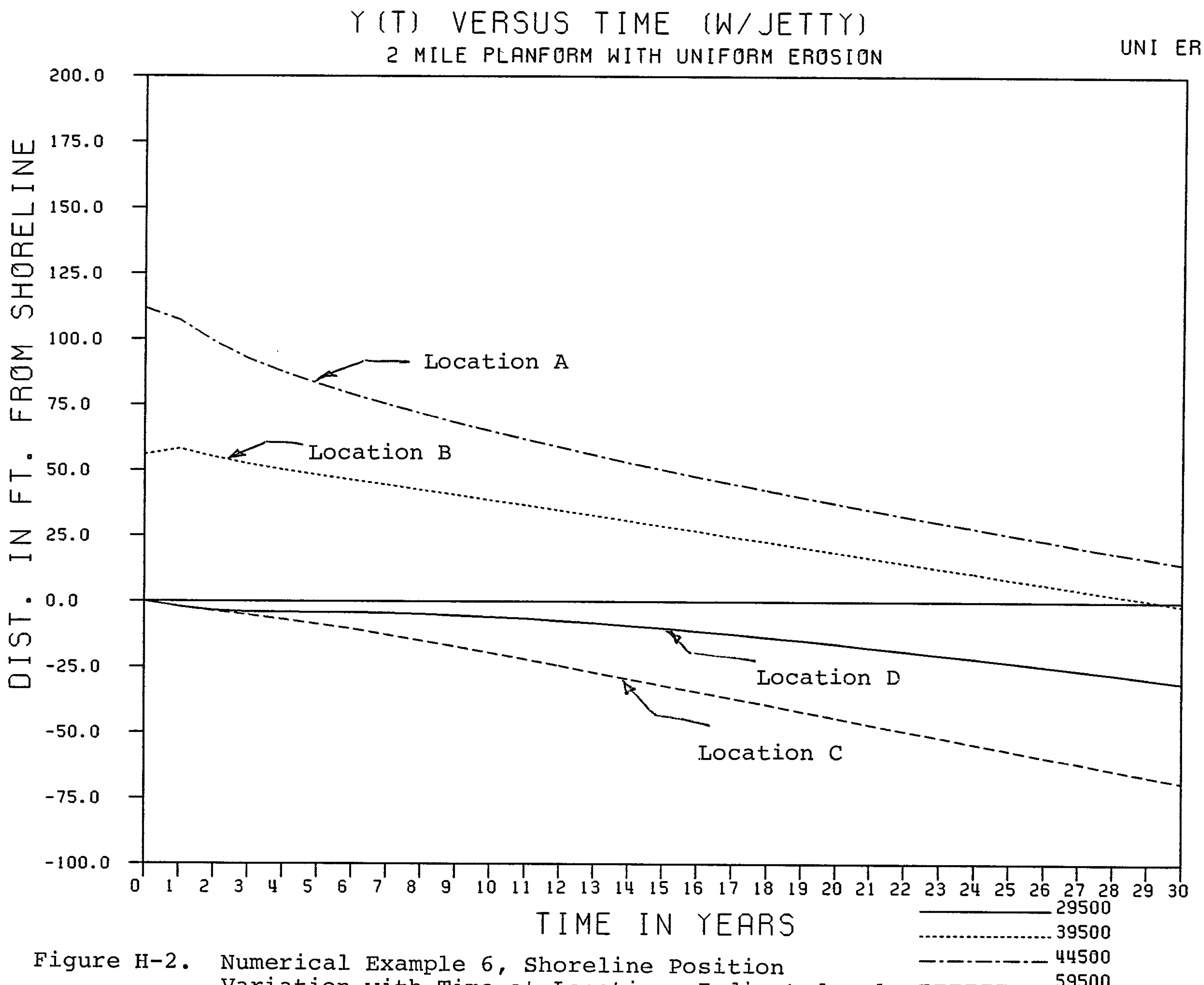


Figure H-2. Numerical Example 6, Shoreline Position Variation with Time at Locations Indicated and Shown in Figure H-1.

INPUT FILE: DNRBS.INP
(Example No. 6)

```
 EXAMPLE NO. 6 NON-UNIF. BACK. EROS. ONE STRUC.
 2.00      6.0     90.0     90.0    180.0    500.0 86400.0
 17.0      6.0     0.77      1.0      0.0     90    180 10950      1
101    112.0
  0.0      2.0   90000.      2.0 100000.      2.0  49500.        3.0
90000.     3.0 100000.      2.0 140000.      2.0
 80    100
 80    112.0
 81    112.0
 82    112.0
 83    112.0
 84    112.0
 85    112.0
 86    112.0
 87    112.0
 88    112.0
 89    112.0
 90    112.0
 91    112.0
 92    112.0
 93    112.0
 94    112.0
 95    112.0
 96    112.0
 97    112.0
 98    112.0
 99    112.0
100    112.0
```

OUTPUT FILE: DNRBS.OUT
(Example No. 6)

EXAMPLE NO. 6 NON-UNIF. BACK. EROS. ONE STRUC.

```
 HO =   2.00 FT., T =   6.00 SEC.,  ALPO =   90.00 DEG., BTAO =   90.00 DEG.,
XMU =  180.00 DEG., DX =   500.00 FT., DT = 86400.00 SEC.
 HSTR =     17.00 FT., B =      6.00 FT., XK =       .77 VFACT =      1.00
    QBKREF =       .00 FT.**3/SEC.
   IREF =      90, IMAX =     180, NTIMES =     10950, NS =      1


   101 112.000


 .00E+00    2.00 .90E+05    2.00 .10E+06    2.00 .50E+05    3.00
 .90E+05    3.00 .10E+06    2.00 .14E+06    2.00
```

BACKGROUND EROSION TRANSPORT RATES

1	-.065	2	-.064	3	-.063	4	-.063	5	-.062
6	-.061	7	-.061	8	-.060	9	-.059	10	-.058
11	-.058	12	-.057	13	-.056	14	-.055	15	-.055
16	-.054	17	-.053	18	-.053	19	-.052	20	-.051
21	-.050	22	-.050	23	-.049	24	-.048	25	-.047
26	-.047	27	-.046	28	-.045	29	-.044	30	-.044
31	-.043	32	-.042	33	-.042	34	-.041	35	-.040
36	-.039	37	-.039	38	-.038	39	-.037	40	-.036
41	-.036	42	-.035	43	-.034	44	-.034	45	-.033
46	-.032	47	-.031	48	-.031	49	-.030	50	-.029
51	-.028	52	-.028	53	-.027	54	-.026	55	-.026
56	-.025	57	-.024	58	-.023	59	-.023	60	-.022
61	-.021	62	-.020	63	-.020	64	-.019	65	-.018
66	-.018	67	-.017	68	-.016	69	-.015	70	-.015
71	-.014	72	-.013	73	-.012	74	-.012	75	-.011
76	-.010	77	-.009	78	-.009	79	-.008	80	-.007
81	-.007	82	-.006	83	-.005	84	-.004	85	-.004
86	-.003	87	-.002	88	-.001	89	-.001	90	.000
91	.001	92	.001	93	.002	94	.003	95	.004
96	.004	97	.005	98	.006	99	.007	100	.007
101	.008	102	.009	103	.009	104	.010	105	.011
106	.012	107	.012	108	.013	109	.014	110	.015
111	.015	112	.016	113	.017	114	.018	115	.018
116	.019	117	.020	118	.020	119	.021	120	.022
121	.023	122	.023	123	.024	124	.025	125	.026
126	.026	127	.027	128	.028	129	.028	130	.029
131	.030	132	.031	133	.031	134	.032	135	.033
136	.034	137	.034	138	.035	139	.036	140	.036
141	.037	142	.038	143	.039	144	.039	145	.040
146	.041	147	.042	148	.042	149	.043	150	.044
151	.044	152	.045	153	.046	154	.047	155	.047
156	.048	157	.049	158	.050	159	.050	160	.051
161	.052	162	.053	163	.053	164	.054	165	.055
166	.055	167	.056	168	.057	169	.058	170	.058
171	.059	172	.060	173	[illegible]	174	.061	175	.062
176	.063	177	.063	178	[illegible]	179	.065	180	.066
181	.066								

80 100

INITIAL SHORELINE (INCL. NOURISHMENT) POSITION

1	0.	.00	2	500.	.00
3	1000.	.00	4	1500.	.00
5	2000.	.00	6	2500.	.00
7	3000.	.00	8	3500.	.00
9	4000.	.00	10	4500.	.00
11	5000.	.00	12	5500.	.00
13	6000.	.00	14	6500.	.00
15	7000.	.00	16	7500.	.00
17	8000.	.00	18	8500.	.00
19	9000.	.00	20	9500.	.00
21	10000.	.00	22	10500.	.00
23	11000.	.00	24	11500.	.00
25	12000.	.00	26	12500.	.00
27	13000.	.00	28	13500.	.00
29	14000.	.00	30	14500.	.00
31	15000.	.00	32	15500.	.00
33	16000.	.00	34	16500.	.00
35	17000.	.00	36	17500.	.00
37	18000.	.00	38	18500.	.00
39	19000.	.00	40	19500.	.00
41	20000.	.00	42	20500.	.00
43	21000.	.00	44	21500.	.00
45	22000.	.00	46	22500.	.00
47	23000.	.00	48	23500.	.00
49	24000.	.00	50	24500.	.00
51	25000.	.00	52	25500.	.00
53	26000.	.00	54	26500.	.00
55	27000.	.00	56	27500.	.00
57	28000.	.00	58	28500.	.00
59	29000.	.00	60	29500.	.00
61	30000.	.00	62	30500.	.00
63	31000.	.00	64	31500.	.00
65	32000.	.00	66	32500.	.00
67	33000.	.00	68	33500.	.00
69	34000.	.00	70	34500.	.00
71	35000.	.00	72	35500.	.00
73	36000.	.00	74	36500.	.00
75	37000.	.00	76	37500.	.00
77	38000.	.00	78	38500.	.00
79	39000.	.00	80	39500.	112.00
81	40000.	112.00	82	40500.	112.00
83	41000.	112.00	84	41500.	112.00
85	42000.	112.00	86	42500.	112.00
87	43000.	112.00	88	43500.	112.00
89	44000.	112.00	90	44500.	112.00
91	45000.	112.00	92	45500.	112.00
93	46000.	112.00	94	46500.	112.00
95	47000.	112.00	96	47500.	112.00
97	48000.	112.00	98	48500.	112.00
99	49000.	112.00	100	49500.	112.00
101	50000.	.00	102	50500.	.00
103	51000.	.00	104	51500.	.00
105	52000.	.00	106	52500.	.00
107	53000.	.00	108	53500.	.00
109	54000.	.00	110	54500.	.00
111	55000.	.00	112	55500.	.00
113	56000.	.00	114	[illegible]	.00
115	57000.	.00	116	[illegible]	.00
117	58000.	.00	118	[illegible]	.00
119	59000.	.00	120	59500.	.00
121	60000.	.00	122	60500.	.00

```
  123    61000.      .00  124    61500.      .00
  125    62000.      .00  126    62500.      .00
  127    63000.      .00  128    63500.      .00
  129    64000.      .00  130    64500.      .00
  131    65000.      .00  132    65500.      .00
  133    66000.      .00  134    66500.      .00
  135    67000.      .00  136    67500.      .00
  137    68000.      .00  138    68500.      .00
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  141    70000.      .00  142    70500.      .00
  143    71000.      .00  144    71500.      .00
  145    72000.      .00  146    72500.      .00
  147    73000.      .00  148    73500.      .00
  149    74000.      .00  150    74500.      .00
  151    75000.      .00  152    75500.      .00
  153    76000.      .00  154    76500.      .00
  155    77000.      .00  156    77500.      .00
  157    78000.      .00  158    78500.      .00
  159    79000.      .00  160    79500.      .00
  161    80000.      .00  162    80500.      .00
  163    81000.      .00  164    81500.      .00
  165    82000.      .00  166    82500.      .00
  167    83000.      .00  168    83500.      .00
  169    84000.      .00  170    84500.      .00
  171    85000.      .00  172    85500.      .00
  173    86000.      .00  174    86500.      .00
  175    87000.      .00  176    87500.      .00
  177    88000.      .00  178    88500.      .00
  179    89000.      .00  180    89500.      .00
  100    116    .000     .019 112.000   -.542   -.542     .019     .000
                     TIME =         1  YEARS
   1   -2.00   2    -2.00   3    -2.00   4    -2.00   5    -2.00   6    -2.00
   7   -2.00   8    -2.00   9    -2.00  10    -2.00  11    -2.00  12    -2.00
  13   -2.00  14    -2.00  15    -2.00  16    -2.00  17    -2.00  18    -2.00
  19   -2.00  20    -2.00  21    -2.00  22    -2.00  23    -2.00  24    -2.00
  25   -2.00  26    -2.00  27    -2.00  28    -2.00  29    -2.00  30    -2.00
  31   -2.00  32    -2.00  33    -2.00  34    -2.00  35    -2.00  36    -2.00
  37   -2.00  38    -2.00  39    -2.00  40    -2.00  41    -2.00  42    -2.00
  43   -2.00  44    -2.00  45    -2.00  46    -2.00  47    -2.00  48    -2.00
  49   -2.00  50    -2.00  51    -2.00  52    -2.00  53    -2.00  54    -2.00
  55   -2.00  56    -2.00  57    -2.00  58    -2.00  59    -1.99  60    -1.98
  61   -1.96  62    -1.93  63    -1.87  64    -1.77  65    -1.60  66    -1.31
  67    -.87  68     -.18  69      .84  70     2.31  71     4.34  72     7.07
  73   10.62  74    15.06  75    20.45  76    26.75  77    33.87  78    41.64
  79   49.83  80    58.17  81    66.36  82    74.13  83    81.26  84    87.56
  85   92.94  86    97.39  87   100.93  88   103.67  89   105.71  90   107.19
  91  108.24  92   108.96  93   109.47  94   109.83  95   110.13  96   110.40
  97  110.69  98   111.04  99   111.46 100   112.02 101    -4.03 102    -3.48
 103   -3.07 104    -2.76 105    -2.53 106    -2.36 107    -2.24 108    -2.15
 109   -2.10 110    -2.06 111    -2.04 112    -2.02 113    -2.01 114    -2.01
 115   -2.00 116    -2.00 117    -2.00 118    -2.00 119    -2.00 120    -2.00
 121   -2.00 122    -2.00 123    -2.00 124    -2.00 125    -2.00 126    -2.00
 127   -2.00 128    -2.00 129    -2.00 130    -2.00 131    -2.00 132    -2.00
 133   -2.00 134    -2.00 135    -2.00 136    -2.00 137    -2.00 138    -2.00
 139   -2.00 140    -2.00 141    -2.00 142    -2.00 143    -2.00 144    -2.00
 145   -2.00 146    -2.00 147    -2.00 148    -2.00 149    -2.00 150    -2.00
 151   -2.00 152    -2.00 153    -2.00 154    -2.00 155    -2.00 156    -2.00
 157   -2.00 158    -2.00 159    -2.00 160    -2.00 161    -2.00 162    -2.00
 163   -2.00 164    -2.00 165    -2.00 166    -2.00 167    -2.00 168    -2.00
 169   -2.00 170    -2.00 171    -2.00 172    -2.00 173    -2.00 174    -2.00
 175   -2.00 176    -2.00 177    -2.0  141    -2.00 179    -2.00 180    -2.00
     LCUR =        1  PCT(LCUR) =
     LCUR =        2  PCT(LCUR) =
     LCUR =        3  PCT(LCUR) =       .75
     LCUR =        4  PCT(LCUR) =       .75
                     TIME =         5  YEARS
```

1	-10.00	2	-10.00	3	-10.00	4	-10.00	5	-10.00	6	-10.00
7	-10.00	8	-10.00	9	-10.00	10	-10.00	11	-10.00	12	-10.00
13	-10.00	14	-10.00	15	-10.00	16	-10.00	17	-10.00	18	-10.00
19	-10.00	20	-10.00	21	-10.00	22	-10.00	23	-10.00	24	-10.00
25	-10.00	26	-10.00	27	-10.00	28	-10.00	29	-10.00	30	-10.00
31	-10.00	32	-10.00	33	-9.99	34	-9.99	35	-9.99	36	-9.98
37	-9.98	38	-9.97	39	-9.96	40	-9.94	41	-9.92	42	-9.90
43	-9.86	44	-9.82	45	-9.77	46	-9.70	47	-9.61	48	-9.50
49	-9.37	50	-9.20	51	-9.00	52	-8.75	53	-8.45	54	-8.10
55	-7.67	56	-7.16	57	-6.56	58	-5.87	59	-5.06	60	-4.13
61	-3.06	62	-1.85	63	-.48	64	1.05	65	2.76	66	4.65
67	6.72	68	8.98	69	11.43	70	14.06	71	16.88	72	19.87
73	23.02	74	26.32	75	29.75	76	33.29	77	36.93	78	40.64
79	44.40	80	48.18	81	51.97	82	55.73	83	59.45	84	63.11
85	66.68	86	70.15	87	73.51	88	76.75	89	79.86	90	82.82
91	85.65	92	88.33	93	90.88	94	93.28	95	95.54	96	97.68
97	99.68	98	101.56	99	103.32	100	104.96	101	-22.03	102	-20.62
103	-19.34	104	-18.16	105	-17.09	106	-16.13	107	-15.28	108	-14.51
109	-13.84	110	-13.25	111	-12.73	112	-12.28	113	-11.90	114	-11.57
115	-11.29	116	-11.06	117	-10.86	118	-10.70	119	-10.56	120	-10.45
121	-10.36	122	-10.28	123	-10.22	124	-10.17	125	-10.14	126	-10.11
127	-10.08	128	-10.06	129	-10.05	130	-10.04	131	-10.03	132	-10.02
133	-10.02	134	-10.01	135	-10.01	136	-10.01	137	-10.00	138	-10.00
139	-10.00	140	-10.00	141	-10.00	142	-10.00	143	-10.00	144	-10.00
145	-10.00	146	-10.00	147	-10.00	148	-10.00	149	-10.00	150	-10.00
151	-10.00	152	-10.00	153	-10.00	154	-10.00	155	-10.00	156	-10.00
157	-10.00	158	-10.00	159	-10.00	160	-10.00	161	-10.00	162	-10.00
163	-10.00	164	-10.00	165	-10.00	166	-10.00	167	-10.00	168	-10.00
169	-10.00	170	-10.00	171	-10.00	172	-10.00	173	-10.00	174	-10.00
175	-10.00	176	-10.00	177	-10.00	178	-10.00	179	-10.00	180	-10.00

LCUR = 5 PCT(LCUR) = .72
LCUR = 6 PCT(LCUR) = .69
LCUR = 7 PCT(LCUR) = .66
LCUR = 8 PCT(LCUR) = .63
LCUR = 9 PCT(LCUR) = .60

TIME = 10 YEARS

1	-20.00	2	-20.00	3	-20.00	4	-20.00	5	-20.00	6	-20.00
7	-20.00	8	-20.00	9	-20.00	10	-20.00	11	-20.00	12	-20.00
13	-19.99	14	-19.99	15	-19.99	16	-19.99	17	-19.99	18	-19.98
19	-19.98	20	-19.97	21	-19.97	22	-19.96	23	-19.95	24	-19.94
25	-19.92	26	-19.91	27	-19.89	28	-19.86	29	-19.83	30	-19.80
31	-19.76	32	-19.71	33	-19.65	34	-19.58	35	-19.50	36	-19.41
37	-19.30	38	-19.18	39	-19.03	40	-18.87	41	-18.68	42	-18.46
43	-18.21	44	-17.93	45	-17.61	46	-17.26	47	-16.86	48	-16.41
49	-15.91	50	-15.35	51	-14.73	52	-14.05	53	-13.31	54	-12.48
55	-11.59	56	-10.61	57	-9.55	58	-8.40	59	-7.17	60	-5.84
61	-4.42	62	-2.90	63	-1.28	64	.43	65	2.24	66	4.14
67	6.14	68	8.23	69	10.41	70	12.68	71	15.03	72	17.45
73	19.95	74	22.51	75	25.13	76	27.79	77	30.51	78	33.25
79	36.03	80	38.82	81	41.62	82	44.42	83	47.21	84	49.99
85	52.74	86	55.46	87	58.14	88	60.77	89	63.34	90	65.85
91	68.29	92	70.65	93	72.94	94	75.14	95	77.25	96	79.27
97	81.19	98	83.01	99	84.74	100	86.36	101	-38.67	102	-37.23
103	-35.86	104	-34.56	105	-33.34	106	-32.20	107	-31.12	108	-30.12
109	-29.18	110	-28.31	111	-27.50	112	-26.75	113	-26.06	114	-25.43
115	-24.85	116	-24.32	117	-23.84	118	-23.40	119	-23.01	120	-22.65
121	-22.33	122	-22.04	123	-21.78	124	-21.55	125	-21.35	126	-21.17
127	-21.01	128	-20.87	129	-20.75	130	-20.64	131	-20.54	132	-20.46
133	-20.39	134	-20.33	135	-20.28	136	-20.24	137	-20.20	138	-20.17
139	-20.14	140	-20.11	141	-20.0	142	-20.08	143	-20.06	144	-20.05
145	-20.04	146	-20.04	147	-20.0		-20.02	149	-20.02	150	-20.02
151	-20.01	152	-20.01	153	-20.C		-20.01	155	-20.01	156	-20.00
157	-20.00	158	-20.00	159	-20.0		-20.00	161	-20.00	162	-20.00
163	-20.00	164	-20.00	165	-20.00	166	-20.00	167	-20.00	168	-20.00
169	-20.00	170	-20.00	171	-20.00	172	-20.00	173	-20.00	174	-20.00
175	-20.00	176	-20.00	177	-20.00	178	-20.00	179	-20.00	180	-20.00

```
LCUR =      10  PCT(LCUR) =      .58
LCUR =      11  PCT(LCUR) =      .55
LCUR =      12  PCT(LCUR) =      .53
LCUR =      13  PCT(LCUR) =      .50
LCUR =      14  PCT(LCUR) =      .48
LCUR =      15  PCT(LCUR) =      .46
LCUR =      16  PCT(LCUR) =      .43
LCUR =      17  PCT(LCUR) =      .41
LCUR =      18  PCT(LCUR) =      .39
LCUR =      19  PCT(LCUR) =      .37
LCUR =      20  PCT(LCUR) =      .35
LCUR =      21  PCT(LCUR) =      .33
LCUR =      22  PCT(LCUR) =      .31
LCUR =      23  PCT(LCUR) =      .29
LCUR =      24  PCT(LCUR) =      .27
LCUR =      25  PCT(LCUR) =      .25
LCUR =      26  PCT(LCUR) =      .23
LCUR =      27  PCT(LCUR) =      .21
LCUR =      28  PCT(LCUR) =      .19
LCUR =      29  PCT(LCUR) =      .17
                TIME =        30  YEARS
  1  -59.99   2  -59.91   3  -59.82   4  -59.73   5  -59.64   6  -59.54
  7  -59.44   8  -59.34   9  -59.24  10  -59.13  11  -59.01  12  -58.89
 13  -58.76  14  -58.62  15  -58.47  16  -58.31  17  -58.15  18  -57.97
 19  -57.78  20  -57.58  21  -57.37  22  -57.14  23  -56.89  24  -56.63
 25  -56.36  26  -56.07  27  -55.75  28  -55.42  29  -55.07  30  -54.70
 31  -54.31  32  -53.89  33  -53.46  34  -52.99  35  -52.50  36  -51.99
 37  -51.45  38  -50.88  39  -50.29  40  -49.66  41  -49.01  42  -48.32
 43  -47.60  44  -46.86  45  -46.08  46  -45.27  47  -44.42  48  -43.54
 49  -42.63  50  -41.69  51  -40.71  52  -39.70  53  -38.65  54  -37.57
 55  -36.46  56  -35.31  57  -34.13  58  -32.92  59  -31.67  60  -30.40
 61  -29.09  62  -27.75  63  -26.39  64  -24.99  65  -23.57  66  -22.12
 67  -20.64  68  -19.15  69  -17.62  70  -16.08  71  -14.52  72  -12.93
 73  -11.34  74   -9.72  75   -8.09  76   -6.45  77   -4.79  78   -3.13
 79   -1.46  80     .22  81    1.91  82    3.59  83    5.28  84    6.97
 85    8.66  86   10.34  87   12.02  88   13.70  89   15.37  90   17.03
 91   18.68  92   20.32  93   21.95  94   23.57  95   25.18  96   26.77
 97   28.35  98   29.91  99   31.46 100   33.00 101  -94.31 102  -92.83
103  -91.39 104  -90.00 105  -88.65 106  -87.33 107  -86.06 108  -84.83
109  -83.65 110  -82.50 111  -81.39 112  -80.32 113  -79.29 114  -78.29
115  -77.34 116  -76.42 117  -75.54 118  -74.69 119  -73.88 120  -73.11
121  -72.36 122  -71.65 123  -70.97 124  -70.33 125  -69.71 126  -69.12
127  -68.56 128  -68.03 129  -67.52 130  -67.04 131  -66.59 132  -66.16
133  -65.75 134  -65.36 135  -65.00 136  -64.66 137  -64.33 138  -64.03
139  -63.74 140  -63.47 141  -63.22 142  -62.98 143  -62.76 144  -62.55
145  -62.36 146  -62.17 147  -62.00 148  -61.85 149  -61.70 150  -61.56
151  -61.43 152  -61.32 153  -61.21 154  -61.10 155  -61.01 156  -60.92
157  -60.84 158  -60.77 159  -60.70 160  -60.63 161  -60.57 162  -60.52
163  -60.47 164  -60.42 165  -60.38 166  -60.34 167  -60.31 168  -60.27
169  -60.24 170  -60.21 171  -60.18 172  -60.16 173  -60.14 174  -60.11
175  -60.09 176  -60.07 177  -60.05 178  -60.03 179  -60.01 180  -59.99
LCUR =      30  PCT(LCUR) =      .15
```

APPENDIX I

NUMERICAL EXAMPLE 7

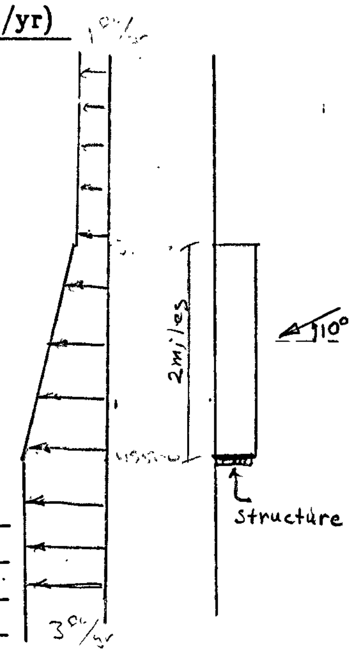
BEACH NOURISHMENT PROJECTION
(Numerical Procedure)

General Location: Example 7

Wave Height, H_0 (Fig. 22):	2.0 ft.,	Closure Depth, h_* (Fig. 8):	17 ft.
Wave Period, T (Fig. 23):	6.0 sec.,	Berm Height, B:	6 ft.
Wave Direction, α_0:	80 °,	Sand Diameter, D:	0.35 mm
Deep Water Contour Orientation, β_0:	90 °,	Transport Factor, K (Fig. 5):	0.77
Longshore Axis Orientation, μ:	180 °,	VFACT:	1.0
Grid Dimension, Δx:	500 ft	Background Transport, QREF:	0.0 ft^3/s
Time Increment, Δt:	86400 sec	IREF:	90
		IMAX:	180
		NTIMES:	10950
		No. of Structures, NS:	1

Structure Specificiation / **Background Erosion**

Structure Number	Structure Location, I	Structure Length (ft)	x	Erosion Rate, ER, (ft/yr)
1	100	112.0	0.0	1.0
2			39500	1.0
3			49500	3.0
4			90000	3.0
5				
6				



Equilibrated Beach Width Δy_0

A_N (Fig. 7) or From Profile:	$ft^{1/3}$
A_F (Fig. 7):	$ft^{1/3}$
Volume Per Unit Length:	ft^3/ft
Δy_0 (Figs. 11 and 12):	112 ft

Nourishment Specification

I Range	Δy_0
80 to 100	112
to	
to	
to	
to	

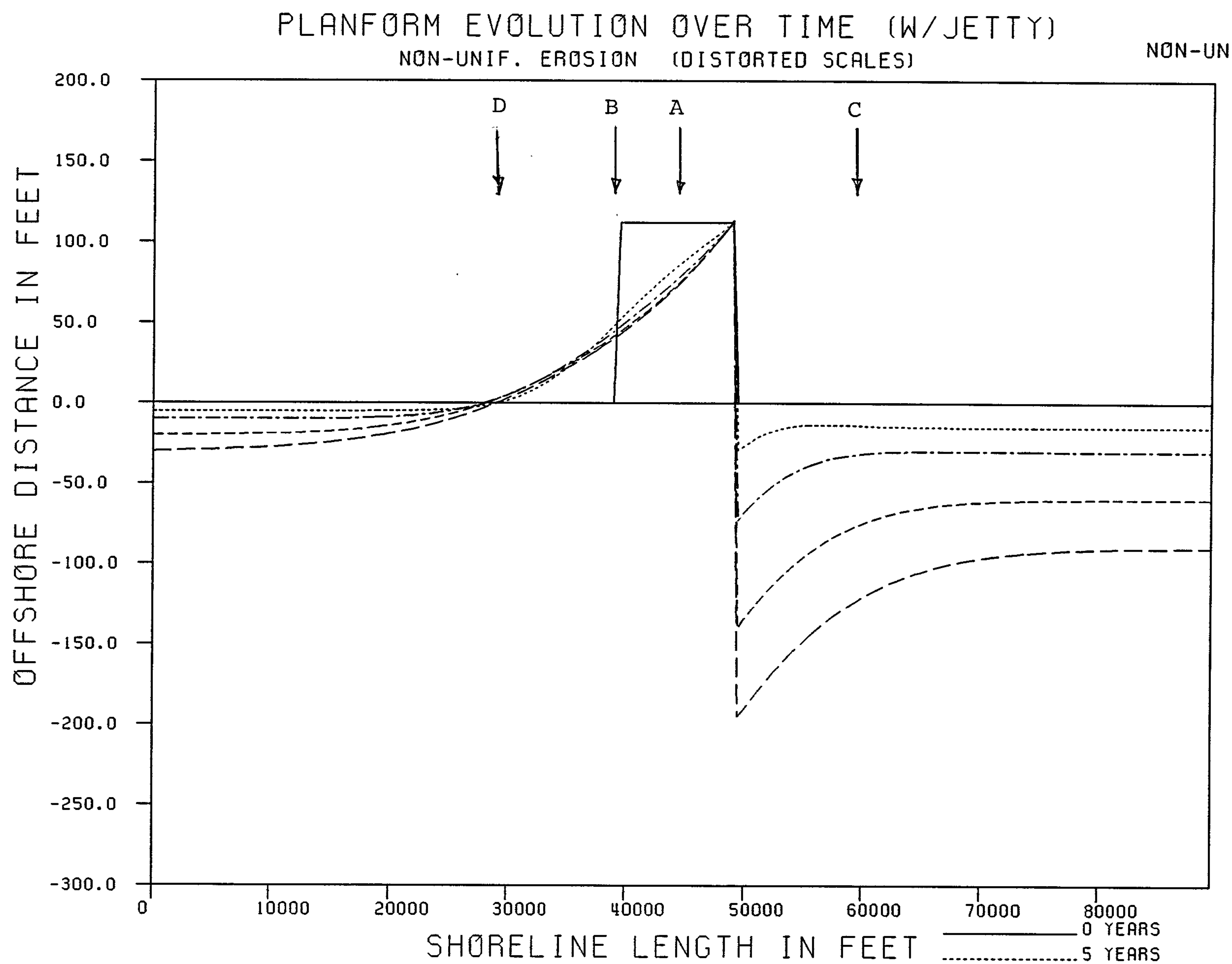


Figure I-1. Numerical Example 7, 112 ft Long Structure at South End of Project, Nourishment Length = 2 Miles, Variable Background Erosion.

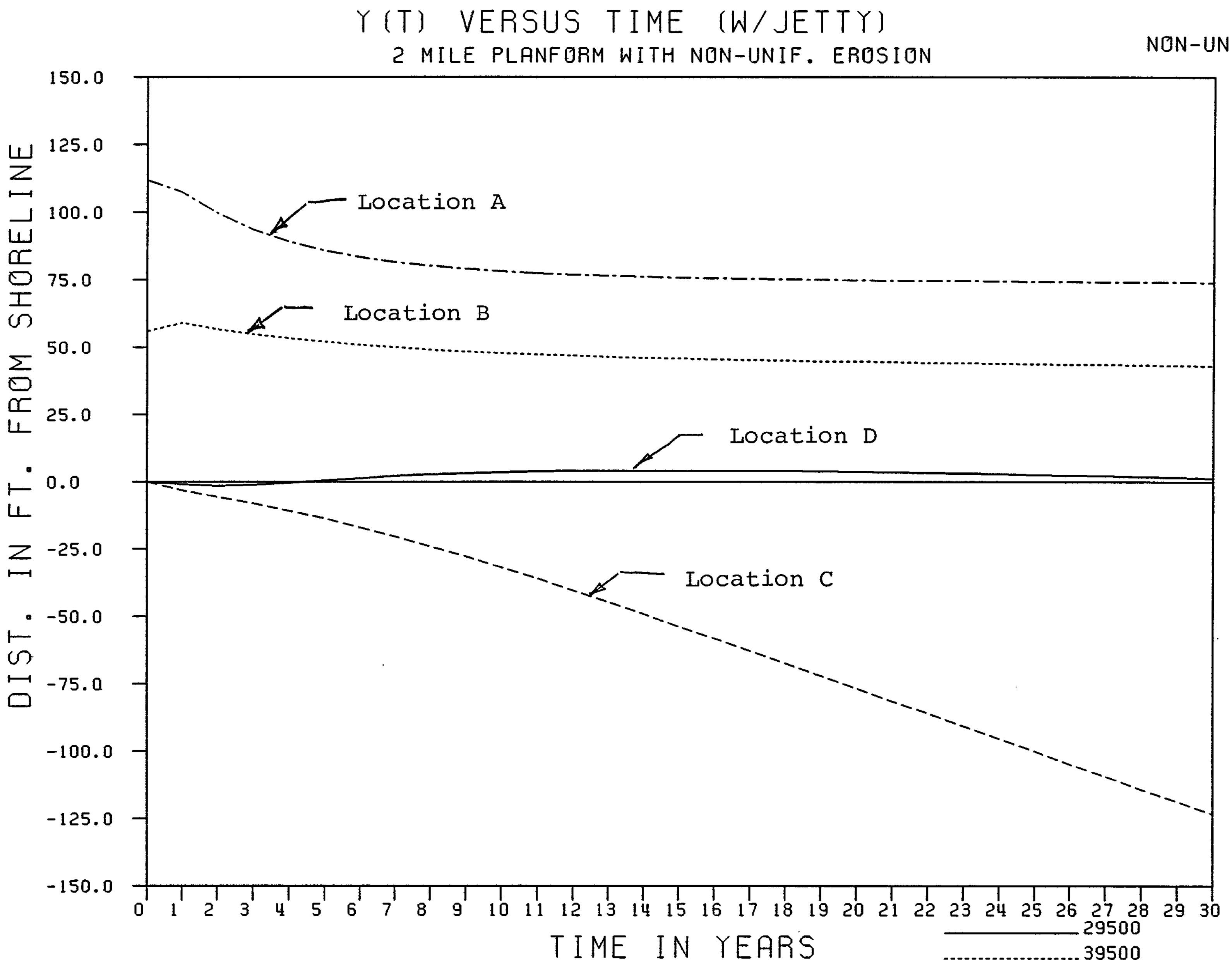


Figure I-2. Numerical Example 7, Shoreline Postiion Variation with Time at Locations Indicated and Shown in Figure I-1.

INPUT FILE: DNRBS.INP
(Example No. 7)

```
 EXAMPLE NO. 7 NON-UNIF. BACK. EROS. ONE STRUC. WAVE ANG.
 2.00      6.0     80.0     90.0    180.0    500.0 86400.0
 17.0      6.0     0.77      1.0      0.0     90    180 10950      1
 101   112.0
  0.0      1.0  39500.      1.0  44500.      2.0  49500.      3.0
90000.     3.0 100000.      2.0 140000.      2.0
  80   100
  80   112.0
  81   112.0
  82   112.0
  83   112.0
  84   112.0
  85   112.0
  86   112.0
  87   112.0
  88   112.0
  89   112.0
  90   112.0
  91   112.0
  92   112.0
  93   112.0
  94   112.0
  95   112.0
  96   112.0
  97   112.0
  98   112.0
  99   112.0
 100   112.0
```

OUTPUT FILE: DNRBS.OUT
(Example No. 7)

EXAMPLE NO. 7 NON-UNIF. BACK. EROS. ONE STRUC. WAVE ANG.

HO = 2.00 FT., T = 6.00 SEC., ALPO = 80.00 DEG., BTAO = 90.00 DEG.,
XMU = 180.00 DEG., DX = 500.00 FT., DT = 86400.00 SEC.
HSTR = 17.00 FT., B = 6.00 FT., XK = .77 VFACT = 1.00
QBKREF = .00 FT.**3/SEC.
IREF = 90, IMAX = 180, NTIMES = 10950, NS = 1

101 112.000

.00E+00	1.00	.40E+05	1.00	.45E+05	2.00	.50E+05	3.00
.90E+05	3.00	.10E+06	2.00	.14E+06	2.00		

BACKGROUND EROSION TRANSPORT RATES

1	-.034	2	-.034	3	-.033	4	-.033	5	-.033
6	-.032	7	-.032	8	-.032	9	-.031	10	-.031
11	-.030	12	-.030	13	-.030	14	-.029	15	-.029
16	-.029	17	-.028	18	-.028	19	-.028	20	-.027
21	-.027	22	-.026	23	-.026	24	-.026	25	-.025
26	-.025	27	-.025	28	-.024	29	-.024	30	-.024
31	-.023	32	-.023	33	-.022	34	-.022	35	-.022
36	-.021	37	-.021	38	-.021	39	-.020	40	-.020
41	-.020	42	-.019	43	-.019	44	-.018	45	-.018
46	-.018	47	-.017	48	-.017	49	-.017	50	-.016
51	-.016	52	-.015	53	-.015	54	-.015	55	-.014
56	-.014	57	-.014	58	-.013	59	-.013	60	-.013
61	-.012	62	-.012	63	-.011	64	-.011	65	-.011
66	-.010	67	-.010	68	-.010	69	-.009	70	-.009
71	-.009	72	-.008	73	-.008	74	-.007	75	-.007
76	-.007	77	-.006	78	-.006	79	-.006	80	-.005
81	-.005	82	-.005	83	-.004	84	-.004	85	-.003
86	-.003	87	-.002	88	-.001	89	-.001	90	.000
91	.001	92	.001	93	.002	94	.003	95	.004
96	.005	97	.006	98	.007	99	.008	100	.009
101	.010	102	.011	103	.012	104	.013	105	.014
106	.015	107	.017	108	.018	109	.019	110	.020
111	.021	112	.022	113	.023	114	.024	115	.025
116	.026	117	.028	118	.029	119	.030	120	.031
121	.032	122	.033	123	.034	124	.035	125	.036
126	.037	127	.038	128	.040	129	.041	130	.042
131	.043	132	.044	13[illegible]	[illegible]45	134	.046	135	.047
136	.048	137	.049	13[illegible]	[illegible]51	139	.052	140	.053
141	.054	142	.055	14[illegible]	[illegible]56	144	.057	145	.058
146	.059	147	.060	14[illegible]	[illegible]61	149	.063	150	.064
151	.065	152	.066	15[illegible]	[illegible]67	154	.068	155	.069
156	.070	157	.071	15[illegible]	[illegible]72	159	.073	160	.075
161	.076	162	.077	163	.078	164	.079	165	.080

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
171	.087	172	.088	173	.089	174	.090	175	.091
176	.092	177	.093	178	.094	179	.095	180	.096
181	.098								

80 100

INITIAL SHORELINE (INCL. NOURISHMENT) POSITION

1	0.	.00	2	500.	.00
3	1000.	.00	4	1500.	.00
5	2000.	.00	6	2500.	.00
7	3000.	.00	8	3500.	.00
9	4000.	.00	10	4500.	.00
11	5000.	.00	12	5500.	.00
13	6000.	.00	14	6500.	.00
15	7000.	.00	16	7500.	.00
17	8000.	.00	18	8500.	.00
19	9000.	.00	20	9500.	.00
21	10000.	.00	22	10500.	.00
23	11000.	.00	24	11500.	.00
25	12000.	.00	26	12500.	.00
27	13000.	.00	28	13500.	.00
29	14000.	.00	30	14500.	.00
31	15000.	.00	32	15500.	.00
33	16000.	.00	34	16500.	.00
35	17000.	.00	36	17500.	.00
37	18000.	.00	38	18500.	.00
39	19000.	.00	40	19500.	.00
41	20000.	.00	42	20500.	.00
43	21000.	.00	44	21500.	.00
45	22000.	.00	46	22500.	.00
47	23000.	.00	48	23500.	.00
49	24000.	.00	50	24500.	.00
51	25000.	.00	52	25500.	.00
53	26000.	.00	54	26500.	.00
55	27000.	.00	56	27500.	.00
57	28000.	.00	58	28500.	.00
59	29000.	.00	60	29500.	.00
61	30000.	.00	62	30500.	.00
63	31000.	.00	64	31500.	.00
65	32000.	.00	66	32500.	.00
67	33000.	.00	68	33500.	.00
69	34000.	.00	70	34500.	.00
71	35000.	.00	72	35500.	.00
73	36000.	.00	74	36500.	.00
75	37000.	.00	76	37500.	.00
77	38000.	.00	78	38500.	.00
79	39000.	.00	80	39500.	112.00
81	40000.	112.00	82	40500.	112.00
83	41000.	112.00	84	41500.	112.00
85	42000.	112.00	86	42500.	112.00
87	43000.	112.00	88	43500.	112.00
89	44000.	112.00	90	44500.	112.00
91	45000.	112.00	92	45500.	112.00
93	46000.	112.00	94	46500.	112.00
95	47000.	112.00	96	47500.	112.00
97	48000.	112.00	98	48500.	112.00
99	49000.	112.00	100	.	112.00
101	50000.	.00	102	.	.00
103	51000.	.00	104	.	.00
105	52000.	.00	106	.	.00
107	53000.	.00	108	.	.00
109	54000.	.00	110	.	.00
111	55000.	.00	112	55500.	.00
113	56000.	.00	114	56500.	.00

117	58000.	.00	118	58500.	.00
119	59000.	.00	120	59500.	.00
121	60000.	.00	122	60500.	.00
123	61000.	.00	124	61500.	.00
125	62000.	.00	126	62500.	.00
127	63000.	.00	128	63500.	.00
129	64000.	.00	130	64500.	.00
131	65000.	.00	132	65500.	.00
133	66000.	.00	134	66500.	.00
135	67000.	.00	136	67500.	.00
137	68000.	.00	138	68500.	.00
139	69000.	.00	140	69500.	.00
141	70000.	.00	142	70500.	.00
143	71000.	.00	144	71500.	.00
145	72000.	.00	146	72500.	.00
147	73000.	.00	148	73500.	.00
149	74000.	.00	150	74500.	.00
151	75000.	.00	152	75500.	.00
153	76000.	.00	154	76500.	.00
155	77000.	.00	156	77500.	.00
157	78000.	.00	158	78500.	.00
159	79000.	.00	160	79500.	.00
161	80000.	.00	162	80500.	.00
163	81000.	.00	164	81500.	.00
165	82000.	.00	166	82500.	.00
167	83000.	.00	168	83500.	.00
169	84000.	.00	170	84500.	.00
171	85000.	.00	172	85500.	.00
173	86000.	.00	174	86500.	.00
175	87000.	.00	176	87500.	.00
177	88000.	.00	178	88500.	.00
179	89000.	.00	180	89500.	.00

100 116 .309 .026 112.000 -.814 -.814 .026 .309

TIME = 1 YEARS

1	-1.00	2	-1.00	3	-1.00	4	-1.00	5	-1.00	6	-1.00
7	-1.00	8	-1.00	9	-1.00	10	-1.00	11	-1.00	12	-1.00
13	-1.00	14	-1.00	15	-1.00	16	-1.00	17	-1.00	18	-1.00
19	-1.00	20	-1.00	21	-1.00	22	-1.00	23	-1.00	24	-1.00
25	-1.00	26	-1.00	27	-1.00	28	-1.00	29	-1.00	30	-1.00
31	-1.00	32	-1.00	33	-1.00	34	-1.00	35	-1.00	36	-1.00
37	-1.00	38	-1.00	39	-1.00	40	-1.00	41	-1.00	42	-1.00
43	-1.00	44	-1.00	45	-1.00	46	-1.00	47	-1.00	48	-1.00
49	-1.00	50	-1.00	51	-1.00	52	-1.00	53	-1.00	54	-1.00
55	-1.00	56	-1.00	57	-1.00	58	-1.00	59	-.99	60	-.98
61	-.97	62	-.94	63	-.89	64	-.79	65	-.63	66	-.37
67	.05	68	.71	69	1.69	70	3.11	71	5.10	72	7.79
73	11.30	74	15.73	75	21.11	76	27.43	77	34.60	78	42.43
79	50.68	80	59.08	81	67.31	82	75.09	83	82.19	84	88.45
85	93.75	86	98.09	87	101.52	88	104.13	89	106.04	90	107.40
91	108.33	92	108.97	93	109.41	94	109.74	95	110.03	96	110.35
97	110.73	98	111.22	99	111.96	100	112.82	101	-6.59	102	-5.72
103	-4.94	104	-4.41	105	-4.01	106	-3.71	107	-3.49	108	-3.33
109	-3.22	110	-3.14	111	-3.09	112	-3.05	113	-3.03	114	-3.02
115	-3.01	116	-3.01	117	-3.00	118	-3.00	119	-3.00	120	-3.00
121	-3.00	122	-3.00	123	-3.00	124	-3.00	125	-3.00	126	-3.00
127	-3.00	128	-3.00	129	-3.00	130	-3.00	131	-3.00	132	-3.00
133	-3.00	134	-3.00	135	-3.[illegible]	[illegible]	-3.00	137	-3.00	138	-3.00
139	-3.00	140	-3.00	141	-3.[illegible]	[illegible]	-3.00	143	-3.00	144	-3.00
145	-3.00	146	-3.00	147	-3.[illegible]	[illegible]	-3.00	149	-3.00	150	-3.00
151	-3.00	152	-3.00	153	-3.[illegible]	[illegible]	-3.00	155	-3.00	156	-3.00
157	-3.00	158	-3.00	159	-3.[illegible]	[illegible]	-3.00	161	-3.00	162	-3.00
163	-3.00	164	-3.00	165	-3.[illegible]	[illegible]	-3.00	167	-3.00	168	-3.00
169	-3.00	170	-3.00	171	-3.00	172	-3.00	173	-3.00	174	-3.00
175	-3.00	176	-3.00	177	-3.00	178	-3.00	179	-3.00	180	-3.00

LCUR = 1 PCT(LCUR) = .89

LCUR = 2 PCT(LCUR) = .84
LCUR = 3 PCT(LCUR) = .80
LCUR = 4 PCT(LCUR) = .77

TIME = 5 YEARS

1	-5.00	2	-5.00	3	-5.00	4	-5.00	5	-5.00	6	-5.00
7	-5.00	8	-5.00	9	-5.00	10	-5.00	11	-5.00	12	-5.00
13	-5.00	14	-5.00	15	-5.00	16	-5.00	17	-5.00	18	-5.00
19	-5.00	20	-5.00	21	-5.00	22	-5.00	23	-5.00	24	-5.00
25	-5.00	26	-5.00	27	-5.00	28	-5.00	29	-5.00	30	-5.00
31	-5.00	32	-5.00	33	-4.99	34	-4.99	35	-4.99	36	-4.99
37	-4.98	38	-4.97	39	-4.96	40	-4.95	41	-4.93	42	-4.91
43	-4.88	44	-4.84	45	-4.79	46	-4.73	47	-4.65	48	-4.55
49	-4.43	50	-4.27	51	-4.08	52	-3.85	53	-3.56	54	-3.22
55	-2.81	56	-2.33	57	-1.76	58	-1.08	59	-.30	60	.60
61	1.64	62	2.83	63	4.17	64	5.67	65	7.35	66	9.20
67	11.25	68	13.48	69	15.89	70	18.50	71	21.27	72	24.22
73	27.32	74	30.57	75	33.94	76	37.41	77	40.96	78	44.56
79	48.20	80	51.84	81	55.45	82	59.03	83	62.55	84	66.00
85	69.36	86	72.63	87	75.80	88	78.88	89	81.85	90	84.74
91	87.54	92	90.28	93	92.97	94	95.64	95	98.31	96	101.02
97	103.80	98	106.68	99	109.74	100	112.65	101	-36.44	102	-33.71
103	-31.00	104	-28.66	105	-26.62	106	-24.84	107	-23.30	108	-21.98
109	-20.84	110	-19.87	111	-19.05	112	-18.35	113	-17.76	114	-17.27
115	-16.85	116	-16.51	117	-16.22	118	-15.99	119	-15.79	120	-15.63
121	-15.51	122	-15.40	123	-15.32	124	-15.25	125	-15.19	126	-15.15
127	-15.12	128	-15.09	129	-15.07	130	-15.05	131	-15.04	132	-15.03
133	-15.02	134	-15.02	135	-15.01	136	-15.01	137	-15.01	138	-15.01
139	-15.00	140	-15.00	141	-15.00	142	-15.00	143	-15.00	144	-15.00
145	-15.00	146	-15.00	147	-15.00	148	-15.00	149	-15.00	150	-15.00
151	-15.00	152	-15.00	153	-15.00	154	-15.00	155	-15.00	156	-15.00
157	-15.00	158	-15.00	159	-15.00	160	-15.00	161	-15.00	162	-15.00
163	-15.00	164	-15.00	165	-15.00	166	-15.00	167	-15.00	168	-15.00
169	-15.00	170	-15.00	171	-15.00	172	-15.00	173	-15.00	174	-15.00
175	-15.00	176	-15.00	177	-15.00	178	-15.00	179	-15.00	180	-15.00

LCUR = 5 PCT(LCUR) = .75
LCUR = 6 PCT(LCUR) = .73
LCUR = 7 PCT(LCUR) = .72
LCUR = 8 PCT(LCUR) = .71
LCUR = 9 PCT(LCUR) = .70

TIME = 10 YEARS

1	-10.00	2	-10.00	3	-10.00	4	-10.00	5	-10.00	6	-10.00
7	-10.00	8	-10.00	9	-10.00	10	-10.00	11	-10.00	12	-10.00
13	-10.00	14	-9.99	15	-9.99	16	-9.99	17	-9.99	18	-9.99
19	-9.98	20	-9.98	21	-9.97	22	-9.97	23	-9.96	24	-9.95
25	-9.93	26	-9.92	27	-9.90	28	-9.88	29	-9.85	30	-9.82
31	-9.78	32	-9.74	33	-9.69	34	-9.62	35	-9.55	36	-9.46
37	-9.36	38	-9.25	39	-9.11	40	-8.96	41	-8.78	42	-8.58
43	-8.34	44	-8.08	45	-7.78	46	-7.44	47	-7.06	48	-6.63
49	-6.15	50	-5.62	51	-5.02	52	-4.37	53	-3.65	54	-2.86
55	-1.99	56	-1.05	57	-.02	58	1.09	59	2.29	60	3.58
61	4.96	62	6.43	63	8.00	64	9.66	65	11.41	66	13.26
67	15.20	68	17.23	69	19.34	70	21.54	71	23.81	72	26.16
73	28.57	74	31.05	75	33.59	76	36.17	77	38.80	78	41.47
79	44.17	80	46.90	81	49.64	82	52.41	83	55.20	84	58.02
85	60.87	86	63.76	87	66.69	88	69.67	89	72.70	90	75.80
91	78.97	92	82.23	93	85.58	94	89.04	95	92.62	96	96.33
97	100.19	98	104.22	99	108.43	100	113.76	101	-77.57	102	-72.34
103	-68.35	104	-64.64	105	-61.22	106	-58.06	107	-55.17	108	-52.52
109	-50.09	110	-47.88	111	-45.8[illegible]	[illegible]	[illegible]44.06	113	-42.42	114	-40.95
115	-39.62	116	-38.43	117	-37.3[illegible]	[illegible]	[illegible]36.43	119	-35.60	120	-34.86
121	-34.20	122	-33.63	123	-33.1[illegible]	[illegible]	[illegible]32.69	125	-32.30	126	-31.97
127	-31.68	128	-31.43	129	-31.2[illegible]	[illegible]	[illegible]31.02	131	-30.86	132	-30.73
133	-30.61	134	-30.51	135	-30.4[illegible]	[illegible]	[illegible]30.35	137	-30.29	138	-30.24
139	-30.20	140	-30.17	141	-30.1[illegible]	[illegible]	-30.11	143	-30.09	144	-30.07
145	-30.06	146	-30.05	147	-30.04	148	-30.03	149	-30.03	150	-30.02
151	-30.02	152	-30.01	153	-30.01	154	-30.01	155	-30.01	156	-30.00

```
157  -30.00 158  -30.00 159  -30.00 160  -30.00 161  -30.00 162  -30.00
163  -30.00 164  -30.00 165  -30.00 166  -30.00 167  -30.00 168  -30.00
169  -30.00 170  -30.00 171  -30.00 172  -30.00 173  -30.00 174  -30.00
175  -30.00 176  -30.00 177  -30.00 178  -30.00 179  -30.00 180  -30.00
    LCUR =      10  PCT(LCUR) =       .69
    LCUR =      11  PCT(LCUR) =       .68
    LCUR =      12  PCT(LCUR) =       .68
    LCUR =      13  PCT(LCUR) =       .67
    LCUR =      14  PCT(LCUR) =       .67
    LCUR =      15  PCT(LCUR) =       .67
    LCUR =      16  PCT(LCUR) =       .67
    LCUR =      17  PCT(LCUR) =       .66
    LCUR =      18  PCT(LCUR) =       .66
    LCUR =      19  PCT(LCUR) =       .66
    LCUR =      20  PCT(LCUR) =       .66
    LCUR =      21  PCT(LCUR) =       .66
    LCUR =      22  PCT(LCUR) =       .65
    LCUR =      23  PCT(LCUR) =       .65
    LCUR =      24  PCT(LCUR) =       .65
    LCUR =      25  PCT(LCUR) =       .65
    LCUR =      26  PCT(LCUR) =       .65
    LCUR =      27  PCT(LCUR) =       .65
    LCUR =      28  PCT(LCUR) =       .65
    LCUR =      29  PCT(LCUR) =       .65
                    TIME =        30  YEARS
  1  -30.00   2  -29.92   3  -29.84   4  -29.75   5  -29.67   6  -29.58
  7  -29.50   8  -29.40   9  -29.31  10  -29.20  11  -29.10  12  -28.98
 13  -28.86  14  -28.73  15  -28.60  16  -28.45  17  -28.29  18  -28.13
 19  -27.95  20  -27.76  21  -27.56  22  -27.34  23  -27.11  24  -26.86
 25  -26.60  26  -26.31  27  -26.01  28  -25.70  29  -25.36  30  -25.00
 31  -24.61  32  -24.21  33  -23.78  34  -23.32  35  -22.84  36  -22.33
 37  -21.80  38  -21.23  39  -20.63  40  -20.00  41  -19.34  42  -18.65
 43  -17.92  44  -17.16  45  -16.36  46  -15.52  47  -14.65  48  -13.73
 49  -12.78  50  -11.78  51  -10.74  52   -9.66  53   -8.54  54   -7.37
 55   -6.16  56   -4.91  57   -3.60  58   -2.25  59    -.85  60     .59
 61    2.09  62    3.63  63    5.22  64    6.87  65    8.56  66   10.31
 67   12.11  68   13.96  69   15.86  70   17.82  71   19.82  72   21.89
 73   24.00  74   26.17  75   28.40  76   30.68  77   33.02  78   35.41
 79   37.86  80   40.37  81   42.94  82   45.57  83   48.27  84   51.05
 85   53.93  86   56.89  87   59.96  88   63.15  89   66.45  90   69.88
 91   73.44  92   77.14  93   81.00  94   85.01  95   89.19  96   93.54
 97   98.07  98  102.80  99  107.63 100  114.06 101 -200.54 102 -194.06
103 -189.14 104 -184.31 105 -179.64 106 -175.14 107 -170.79 108 -166.61
109 -162.59 110 -158.72 111 -155.00 112 -151.44 113 -148.02 114 -144.74
115 -141.61 116 -138.62 117 -135.76 118 -133.03 119 -130.43 120 -127.95
121 -125.59 122 -123.35 123 -121.23 124 -119.21 125 -117.30 126 -115.49
127 -113.78 128 -112.16 129 -110.64 130 -109.20 131 -107.85 132 -106.57
133 -105.38 134 -104.25 135 -103.20 136 -102.21 137 -101.29 138 -100.42
139  -99.61 140  -98.86 141  -98.16 142  -97.51 143  -96.90 144  -96.33
145  -95.81 146  -95.32 147  -94.87 148  -94.46 149  -94.07 150  -93.72
151  -93.39 152  -93.09 153  -92.81 154  -92.55 155  -92.32 156  -92.10
157  -91.90 158  -91.72 159  -91.56 160  -91.41 161  -91.27 162  -91.14
163  -91.02 164  -90.92 165  -90.82 166  -90.73 167  -90.65 168  -90.58
169  -90.51 170  -90.45 171  -90.39 172  -90.33 173  -90.28 174  -90.24
175  -90.19 176  -90.15 177  -90.11 178  -90.07 179  -90.03 180  -90.00
    LCUR =      30  PCT(LCUR) =       .65
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