MARINA DEL REY AND BALLONA CREEK FEASIBILITY STUDY

DREDGED MATERIAL MANAGEMENT PLAN ALTERNATIVES ANALYSIS AND REPORT

PRELIMINARY SUBMITTAL
TASK 4: AUTHORIZED MAINTENANCE PRISM

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INTRODUCTION

Purpose

The purpose of the Dredged Material Management Plan (DMMP) Alternatives Analysis and Report is to analyze alternatives for the disposal of contaminated dredged sediments originating from Marina del Rey Harbor. Four DMMP alternatives were identified for investigation including:

- Alternative 1 - North Energy Island Borrow Pit (NEIBP) CAD Site
- Alternative 2 - Long Beach Breakwater Shallow Water Habitat CAD Site
- Alternative 3 - Port of Long Beach Pier S Landfill
- Alternative 4 - Modification of the Authorized Maintenance Dredging Prism

This preliminary report presents the findings of the evaluation of Alternative 4 only.

Scope

The scope of the Alternative 4 analysis included the following:

- Determine the necessary channel depths in the South Entrance Channel, North Entrance Channel, mouth of Ballona Creek, and the North Jetty Fillet to establish dredge frequencies of 5, 10, 15, and 20 years at Marina del Rey. These areas are identified in Figure 1 as Areas A, B, G, and H, respectively.
- Recommend the optimum frequency based on dredged volumes and construction cost.

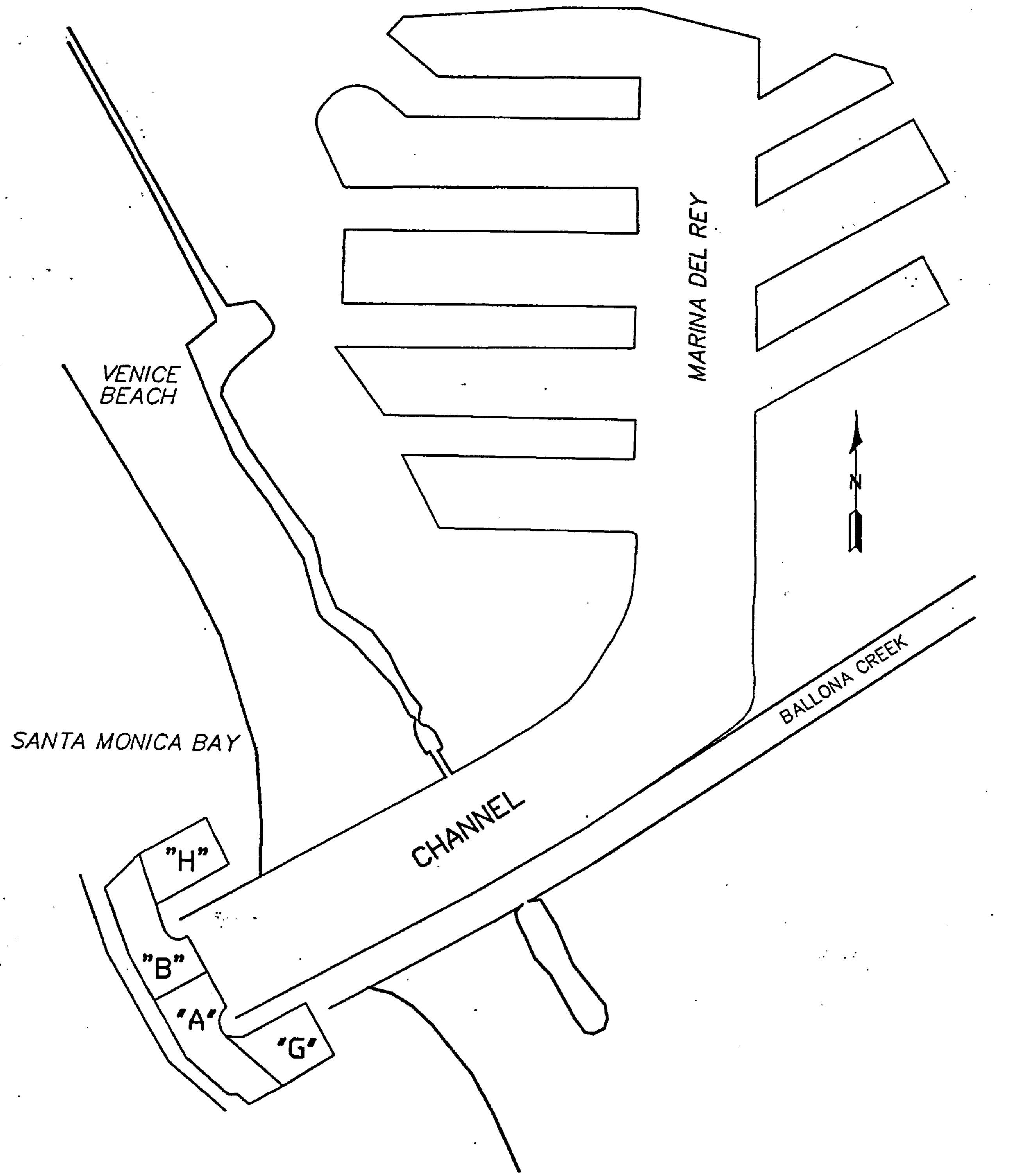
EXISTING CONDITIONS

Harbor Entrance Dimensions

The first step in the advanced maintenance prism evaluation was to identify the existing harbor entrance dimensions. Table 1 summarizes the areas used for the analysis. Area A and Area B refer to the south and north portions of the federal entrance channel between the jetties and the detached breakwater, respectively. Area dimensions were measured from digital survey drawings. Area G refers to the mouth of Ballona Creek. Area H refers to the sand fillet formed at the north jetty. The area dimensions of Area G and Area H were also measured from historic advanced maintenance dredging episodes in these areas. Any necessity to increase the plan area of these advanced dredging areas is addressed in the alternative analysis.

Table 1 - Surface Areas for Areas A, B, G, and H

Area A	Area B	Area G	Area H
43,200 m^2	40,200 m^2	28,200 m^2	26,700 m^2



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100 0 200 400
UNITS = METERS

MARINA DEL REY SEDIMENT STUDY	FEDERAL CHANNEL BOUNDARIES	Figure 1

The current authorized depth within the federal channel (Area A and Area B) is –6.1 meters MLLW.

Existing Shoal Volumes and Rates

The existing shoal condition was assumed to be represented by the September 1996 bathymetric survey, since this was used as the existing condition baseline in prior feasibility study tasks, including the shoaling rate analysis for advanced maintenance depth alternatives. The shoal volume in Area A and Area B above the authorized depth of –6.1 meters MLLW was calculated based on the September 1996 bathymetric survey to be 41,200 cubic meters and 62,300 cubic meters, respectively.

The existing shoaling rates within the Marina del Rey harbor entrance were estimated from historical survey data as part of the sediment budget analysis included in the *Sediment Transport Analysis and Report* (90% Submittal, October 1998). The rates are illustrated in Figure 2 and summarized by area in Table 2.

Table 2 - Average Annual Shoal Rate by Area

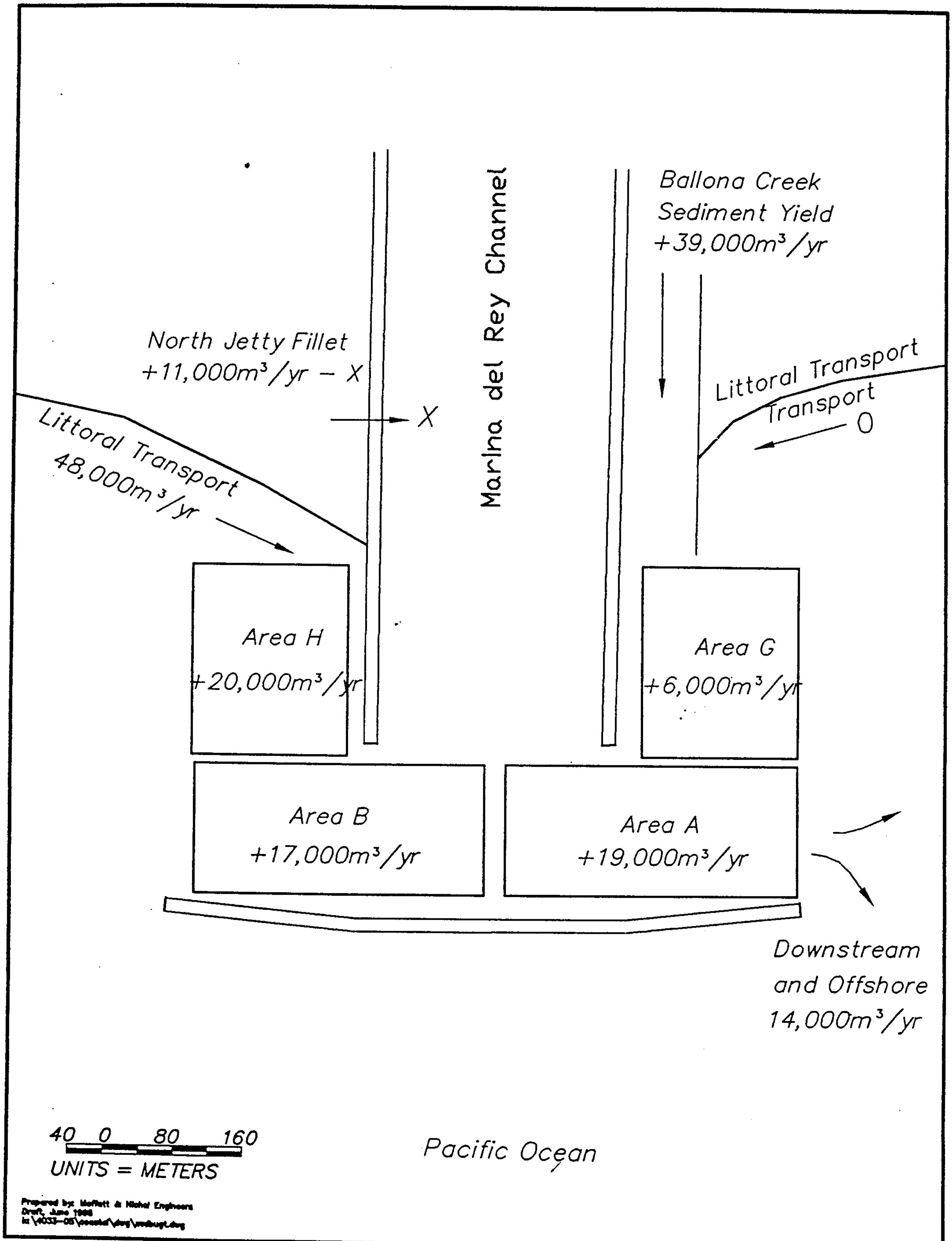
Area A	Area B	Area G	Area H
19,000 m^3/year	17,000 m^3/year	6,000 m^3/year	20,000 m^3/year

The effect of deepening the authorized maintenance prism on these shoaling rates is addressed in the *Analysis* section of this report.

ANALYSIS

Having defined the existing entrance channel configuration and shoaling rates, the next step is the analysis phase in which a range of advanced maintenance dredging prisms are evaluated. The analysis approach is summarized as follows:

- Define the shoal condition at which point maintenance dredging is assumed to be warranted.
- Calculate the required shoal volume capacity of the various entrance channel areas for the various maintenance dredging intervals under consideration.
- Account for acceleration (or deceleration) of shoaling rates associated with advanced maintenance dredging.
- Evaluate the feasibility of dredging to the depths indicated by the volume analysis, considering proximity to navigation structures.
- Specify the fate of the dredged material for cost analysis purposes, i.e. nearshore disposal, offshore disposal, and contained aquatic disposal (assumed for the contaminated fraction).
- Perform annualized cost analysis for the various alternatives to identify a least cost alternative.



MARINA DEL REY SEDIMENT STUDY | SEDIMENT BUDGET | Figure 2

Maximum Shoal Condition Prior to Dredging

Dredge frequency analyses require identification of the shoal condition at which the next dredge cycle is required. Such a determination is typically based on a maximum acceptable level of navigation restriction. However, identification of a maximum amount of navigation restriction can be somewhat arbitrary. Using the *Boat Traffic Impact Assessment* (May 1998), it was assumed that dredging was required when navigation for the deepest draft vessels was restricted to 50 percent of the north entrance and 25 percent of the south entrance. This condition was identified as the maximum amount of acceptable navigation restriction under typical summer weekend conditions.

Historic condition surveys of the entrance channels were analyzed to develop relationships between level of navigation restriction and associated shoal volume. For a given condition survey, the shoal volume in the north and south entrance channel was first calculated. Then, for each vessel length class, the percent width of the entrance channel that was at the minimum navigation depth or greater was measured. This related shoal volume to percent of navigable channel for each vessel class. This was done for each vessel length class and for both the north and south entrance channels. Figures 3 and 4 are plots for the deepest draft (27-30m length class). Note the substantial scatter in the data as would be expected. Best fit linear relationships were then developed to predict shoal volume associated with the percent of available open channel. Shoal volumes associated with a 50 percent open north channel and 25 percent open south channel are 70,000 cubic meters in Area A and 40,000 cubic meters in Area B, respectively. Again, these shoal volumes are volumes above the –6.1 meter MLLW federal channel depth.

Shoal volumes were converted to equivalent shoal depth for purposes of the analysis. It is acknowledged, however, that the shoaling does not occur evenly over the channel area. The equivalent shoal depths were calculated for the pre-dredge condition as follows:

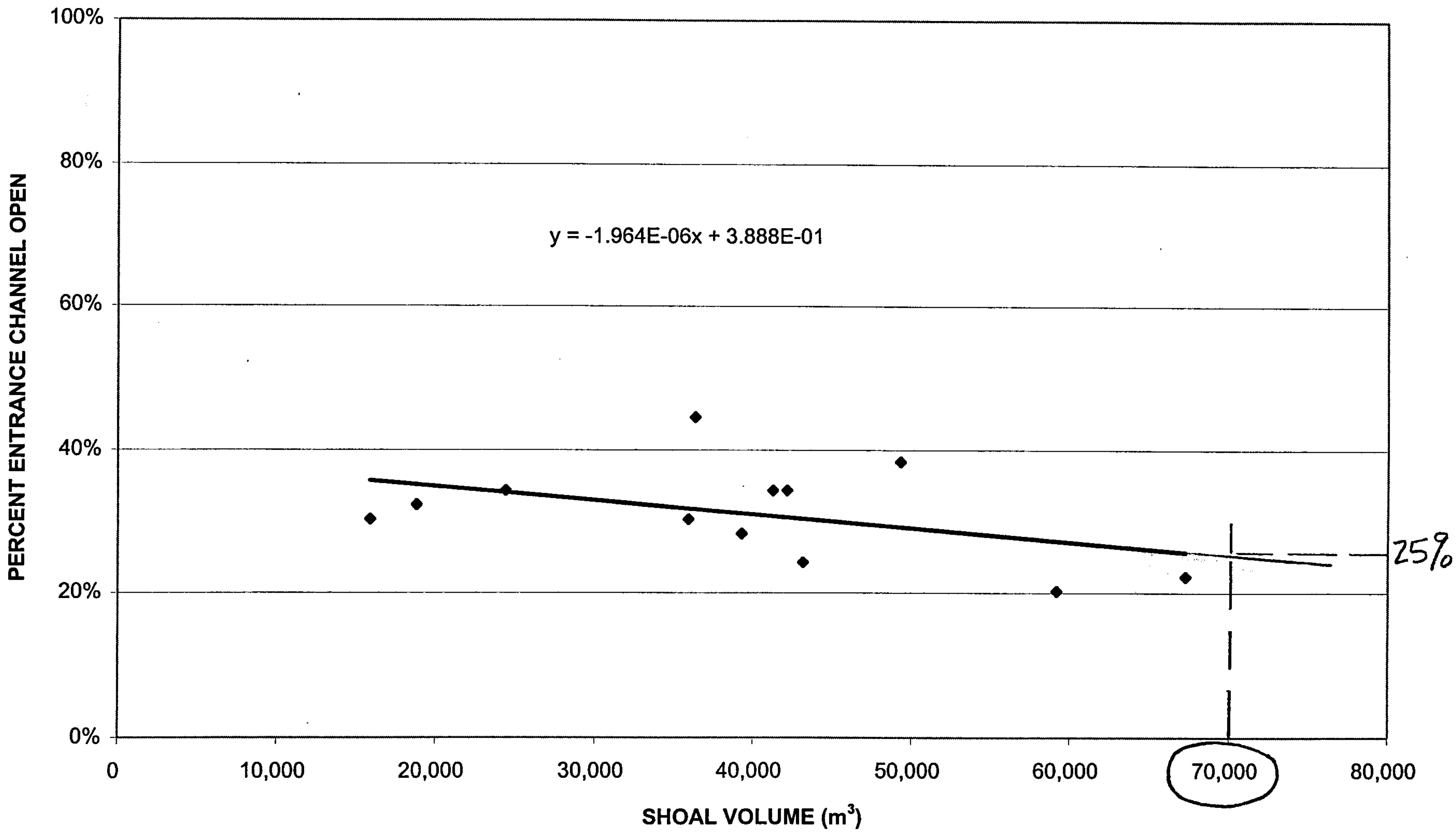
D_{Amin}= Design Depth + Shoal Volume/Deposition Area
= -6.1+70,000/43,200= -4.5 meters MLLW

Similarly, D_{Bmin}= -5.1 meters MLLW. Corresponding equivalent depths in Areas G and H were assumed as the averaged September 1996 survey results in the corresponding areas. These were –4.0 meters MLLW in Area G and –4.5 meters MLLW in Area H, respectively.

Change of Shoal Rate as a Result of Advanced Maintenance Dredging

The shoal rates described previously will change if the channel depth changes. Results from the previous sediment transport numerical model studies described in the *Sediment Transport Analysis and Report* (90% Submittal, October 1998) were used to develop a relationship between the shoal rate and the water depth in the different areas of interest.

SHOAL VOLUME vs. CHANNEL WIDTH
(27 to 30m BOATS)



SOUTH

FIGURE 3

SHOAL VOLUME vs. CHANNEL WIDTH (27 to 30m BOATS)

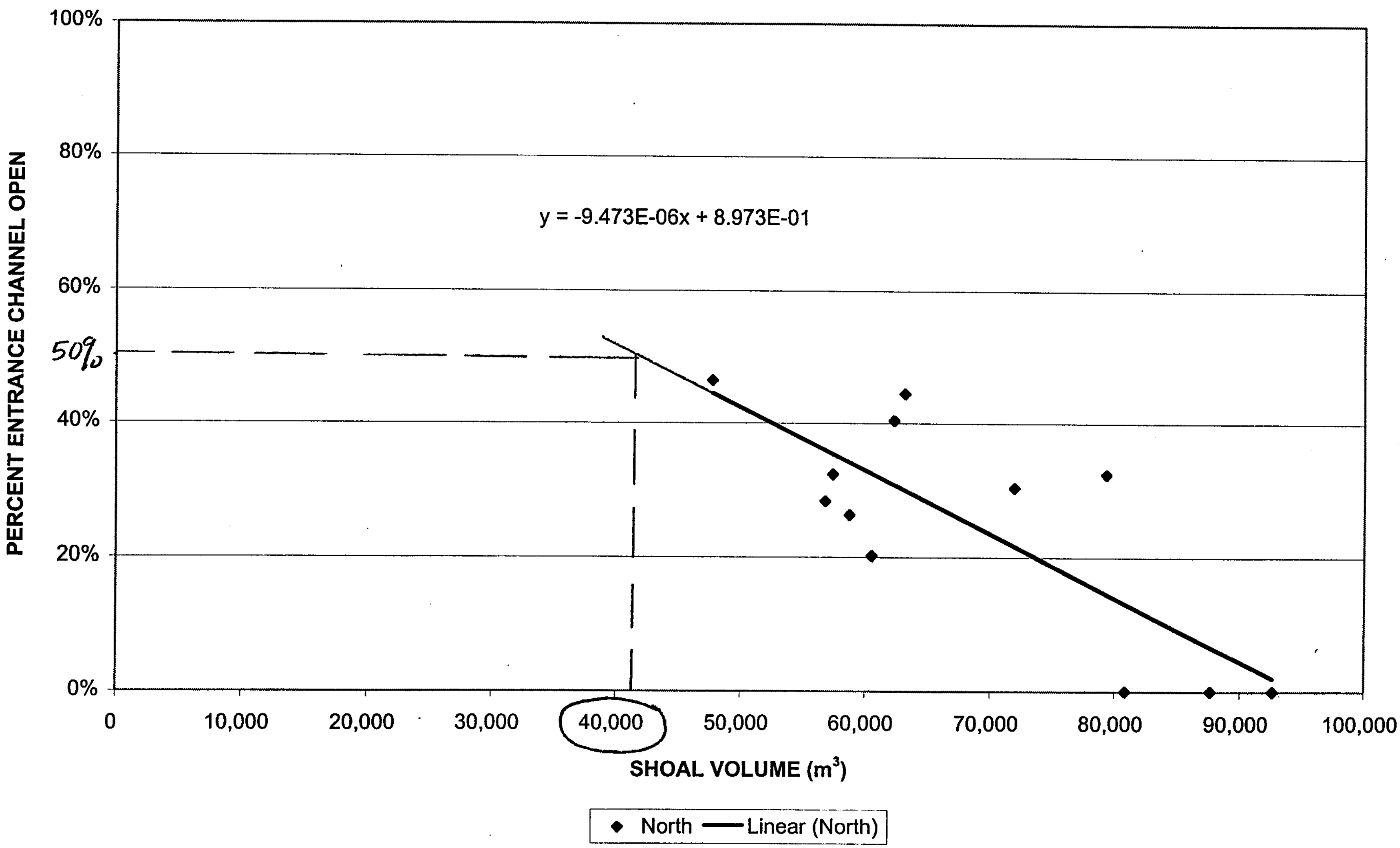


FIGURE 4

Three different channel depths (Alternatives) were modeled as part of the *Sediment Transport Study* including: Existing (September 1996 Bathymetry), Alternative 1 (-6.1 meter, MLLW) and Alternative 2 (-9.1 meters, MLLW). In that study, shoal volumes were calculated for each alternative in each of the four harbor entrance areas for the same flood event. Volume differences were then calculated between the alternatives in the same area. This difference then was divided by the total shoal volume of the shallower alternative and also by the average depth difference between the two alternatives. This resulted the shoal rate change per unit depth change. The shoal rate changes for the flood dominated Area A and G are shown in Figures 5 and 6, respectively. It can be seen that, as Area A and Area G are deepened concurrently, more sediment would settle in Area G (positive rate change) and less in Area A (negative rate change).

Shoaling in Areas B and H is considered to be dominated by the longshore sediment transport from the north. No numerical modeling of the impact of advanced dredging in these areas was performed as part of this overall Feasibility Study. Based on the similar general geometric configurations of the channels and shoals, it was assumed that Area B has the same shoal rate change by depth as Area A and Area H has the same shoal rate change by depth as Area G.

Required Shoal Volume Capacities

Future shoal volumes based on historical rates (Table 2), i.e. before applying the shoal rate changes, are shown in Table 3.

Table 3 - Cumulative Shoal Volume by Area Based on Historical Rates

Dredge Frequency (Yrs)	Area A (m^3)	Area B (m^3)	Area G (m^3)	Area H (m^3)
5	95,000	85,000	30,000	100,000
10	190,000	170,000	60,000	200,000
15	285,000	255,000	90,000	300,000
20	380,000	340,000	120,000	400,000

Preliminary advanced dredging depths were calculated using the values in Table 3. After obtaining the advance depth, a shoal rate change was selected from the relationships illustrated in Figures 5 and 6. The shoal rate then was modified to account for the effects of the depth change. The advance depths were then re-calculated.

Based on current harbor dredging practices, the external boundaries of the dredge areas were assumed to have a dredged slope of 1 (vertical) vs. 3 (horizontal). Calculated shoal volumes and advance dredge depths are shown in Tables 4 and 5, respectively.

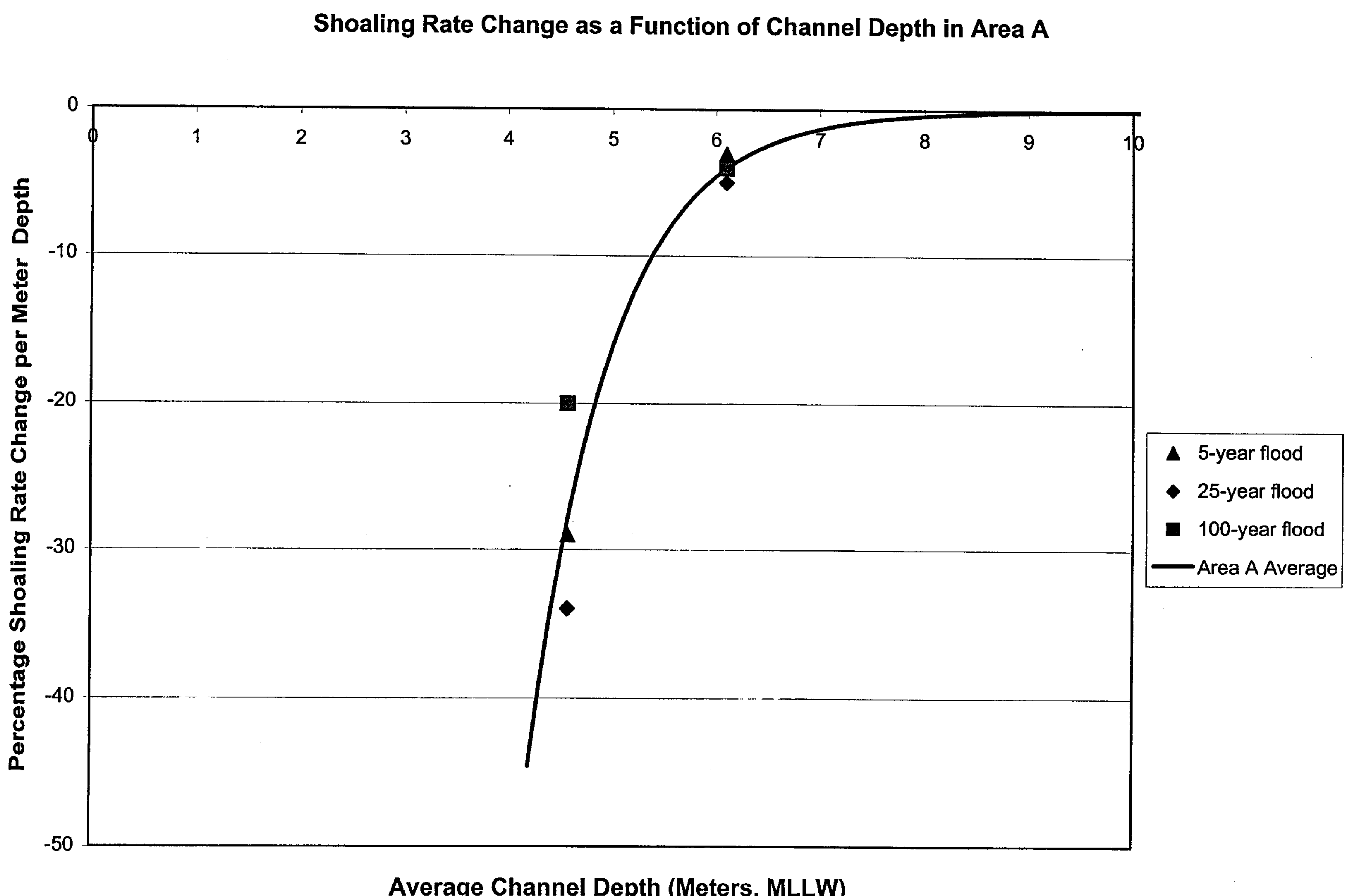
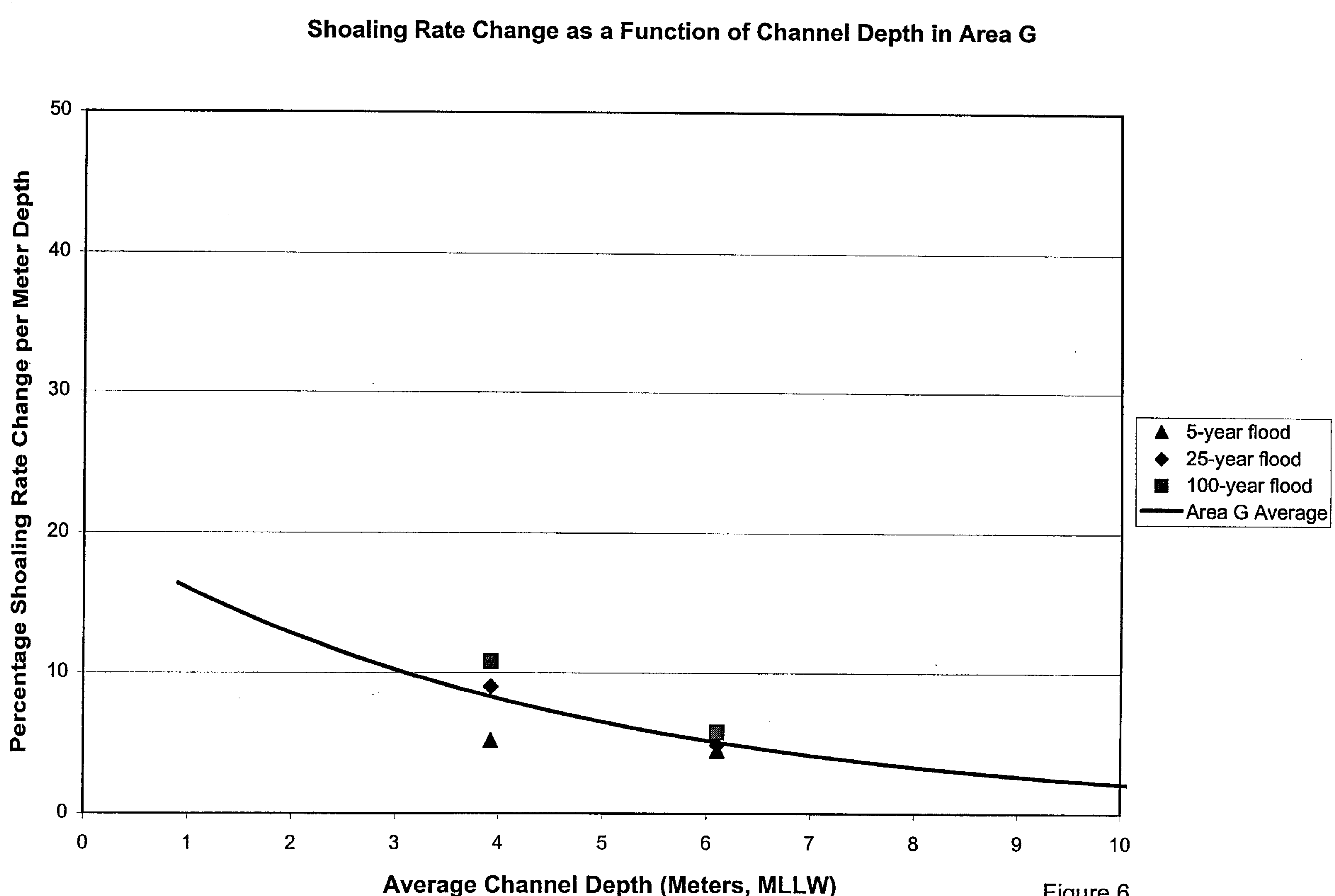

Shoaling Rate Change as a Function of Channel Depth in Area A
0
-10
-20
-30
-40
-50
0
1
2
3
4
5
6
7
8
9
10
Percentage Shoaling Rate Change per Meter Depth
Average Channel Depth (Meters, MLLW)
5-year flood
25-year flood
100-year flood
Area A Average

Figure 5



Shoaling Rate Change as a Function of Channel Depth in Area G
Percentage Shoaling Rate Change per Meter Depth
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
Average Channel Depth (Meters, MLLW)
5-year flood
25-year flood
100-year flood
Area G Average

Figure 6

Table 4 - Cumulative Shoal Volume after Shoal Rate Modification

Dredge Frequency (Yrs)	Area A (m^3)	Area B (m^3)	Area G (m^3)	Area H (m^3)
5	93,480	84,235	31,920	102,900
10	189,867	169,932	63,000	201,600
15	285,000	255,000	93,330	300,000
20	380,000	340,000	123,240	400,000

Table 5 - Advance Dredge Depth (Meters, MLLW)

Dredge Frequency (yrs)	Area A	Area B	Area G	Area H
5	6.8	7.3	5.2	8.9
10	9.3	9.7	6.4	14.7
15	12	12.3	7.7	24.5
20	15	15.2	9.1	---

In Area H, the advance depth would be too deep to accommodate the cumulated shoal volume based on the assumed advance dredging area. Assuming the advance dredging area is doubled by extending it landward, the following advance dredge depths for Area H are calculated:

Table 6 - Advance Dredge Depth for Area H with Revised Area (Meters, MLLW)

Dredge Frequency (Yrs)	Area H
5	6.6
10	8.7
15	11.1
20	13.5

Feasibility of Advanced Dredge Depth Scenarios

Cross sections of the various advanced dredging scenarios are included in Figures 7 through 10. As shown in the sections, dredge cuts were assumed to be on a 1:3 (V:H) slope with an 18 meter buffer between the top of slope and adjacent navigation structure. This is consistent with early rules-of-thumb regarding proximity of dredged channels to navigation structures. More recent guidelines include allowance for some natural sloughing of the 1:3 slope to a flatter 1:5 slope. The issue is whether the toe of the navigation structure could be undermined if the dredged slope evolved to the flatter slope. Figures 8 through 10 illustrate this slope projection. Figure 8 and 9 indicate that dredging should not exceed the 15-year scenario for Area A and Area B, respectively. Figure 10 indicates that no restriction is required for any of the dredge scenarios for Areas G and H.

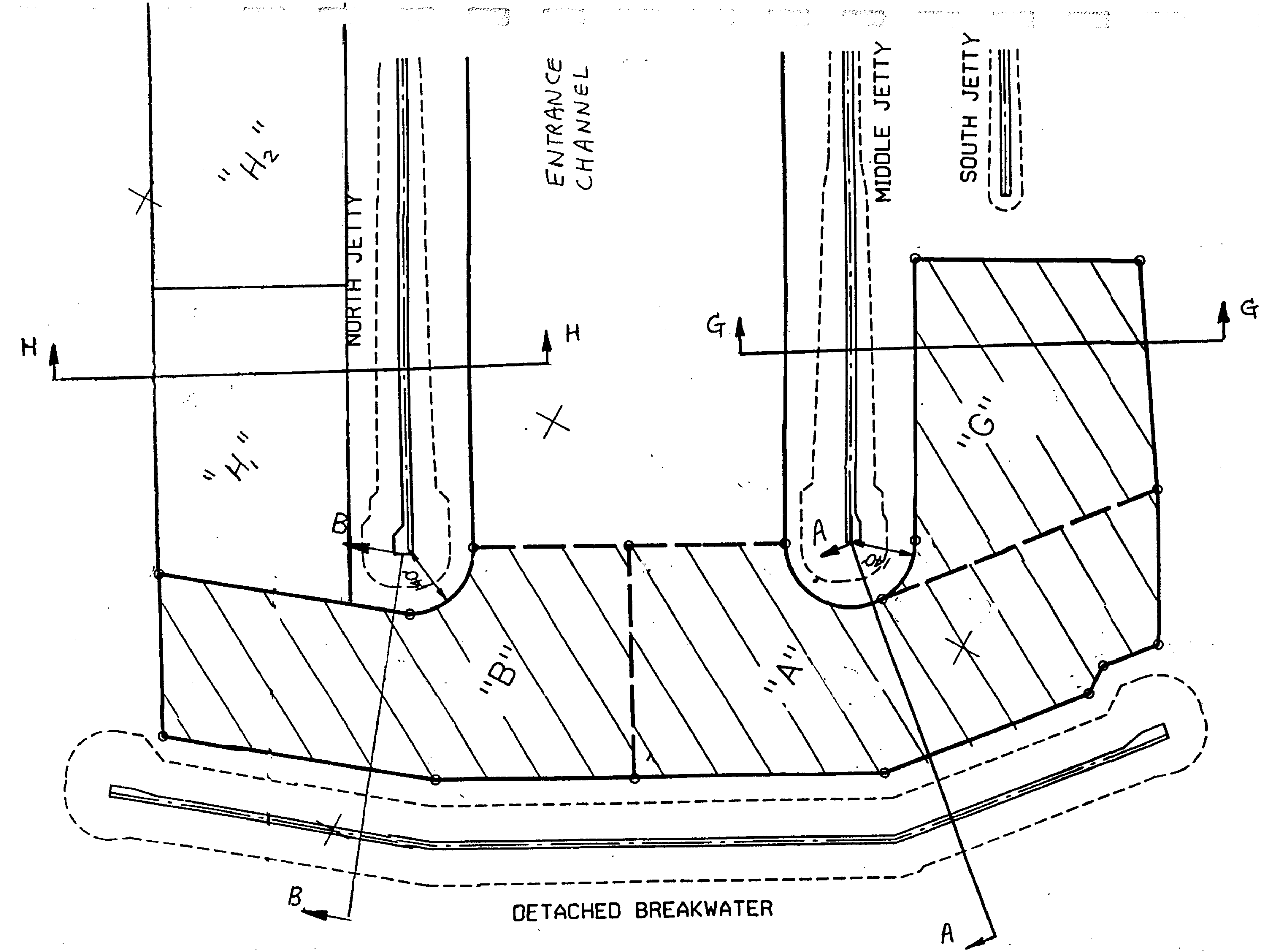
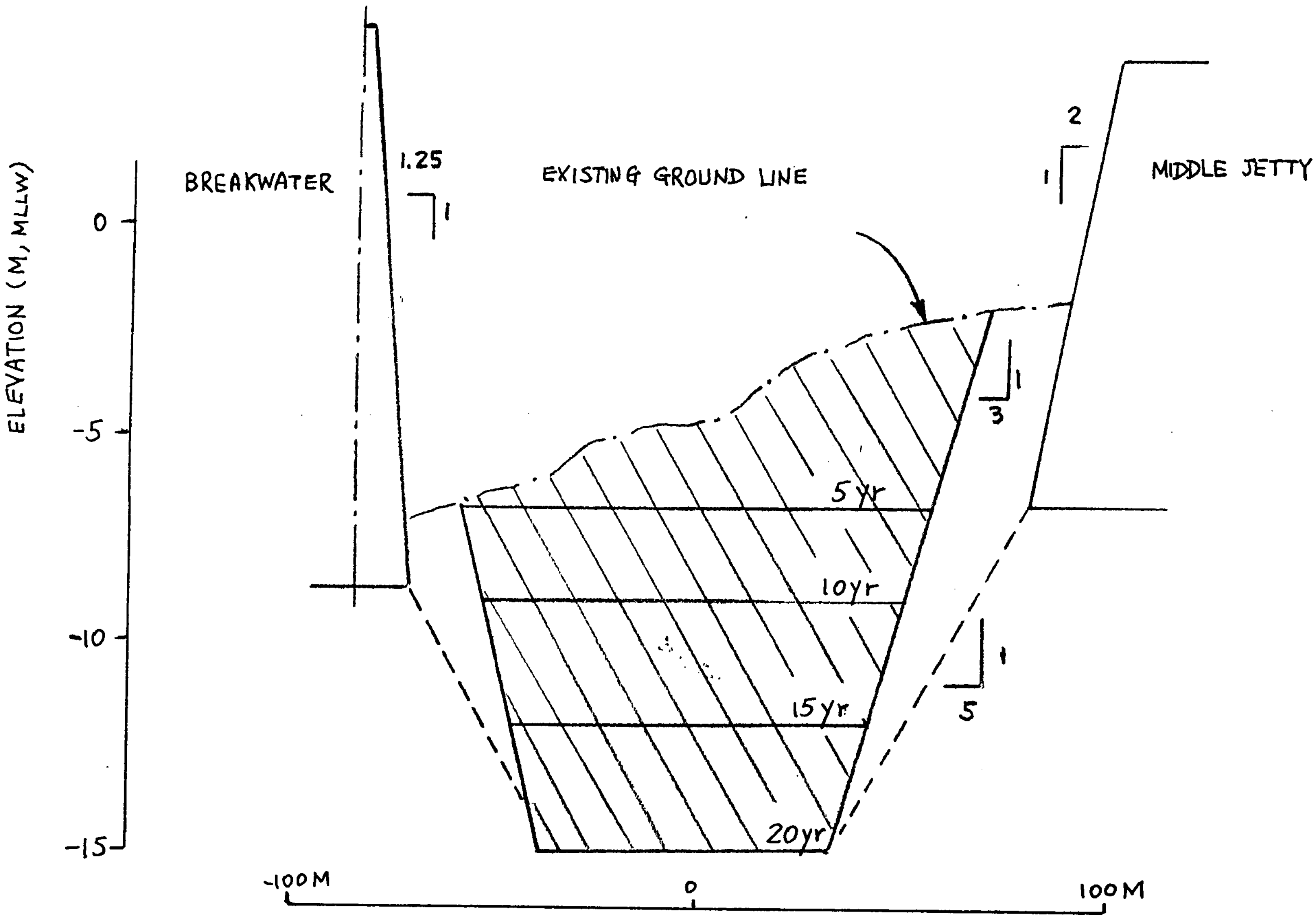
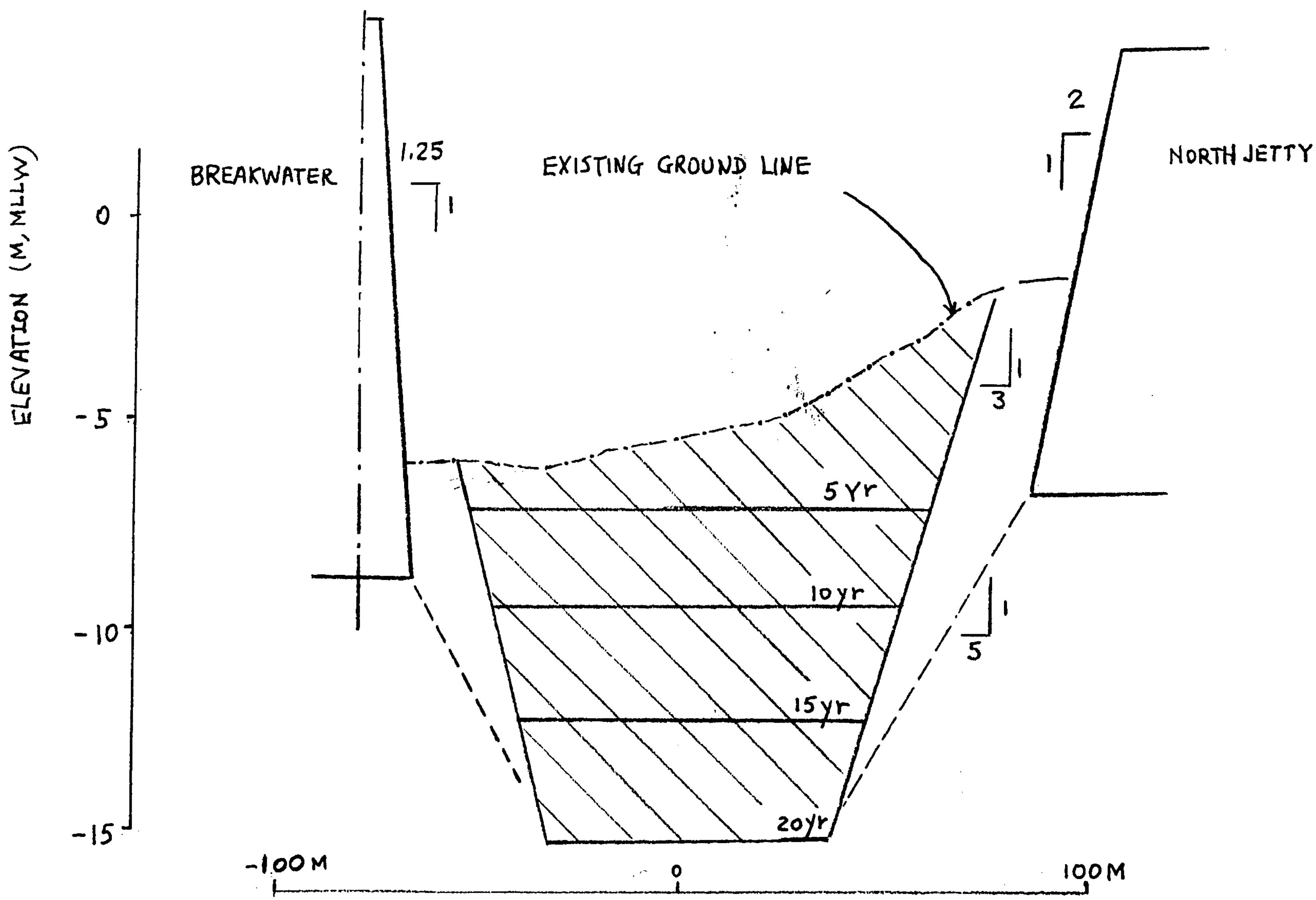

"H2"
"H1"
NORTH JETTY
ENTRANCE CHANNEL
MIDDLE JETTY
SOUTH JETTY
H
H
G
G
B
B
A
A
140'
140'
"G"
"B"
"A"
DETACHED BREAKWATER

Figure 7



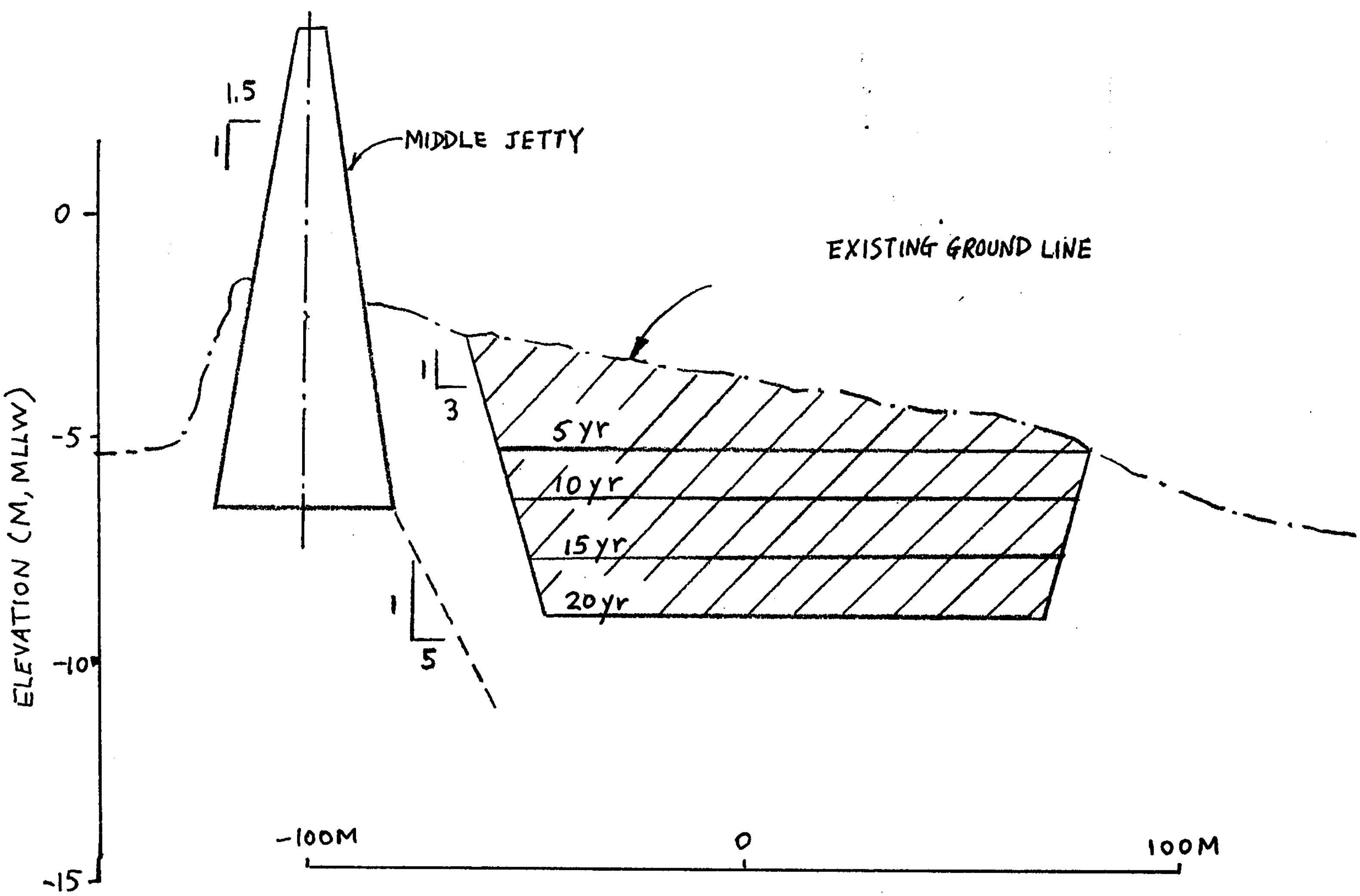
SECTION A-A (AREA A)

Figure 8



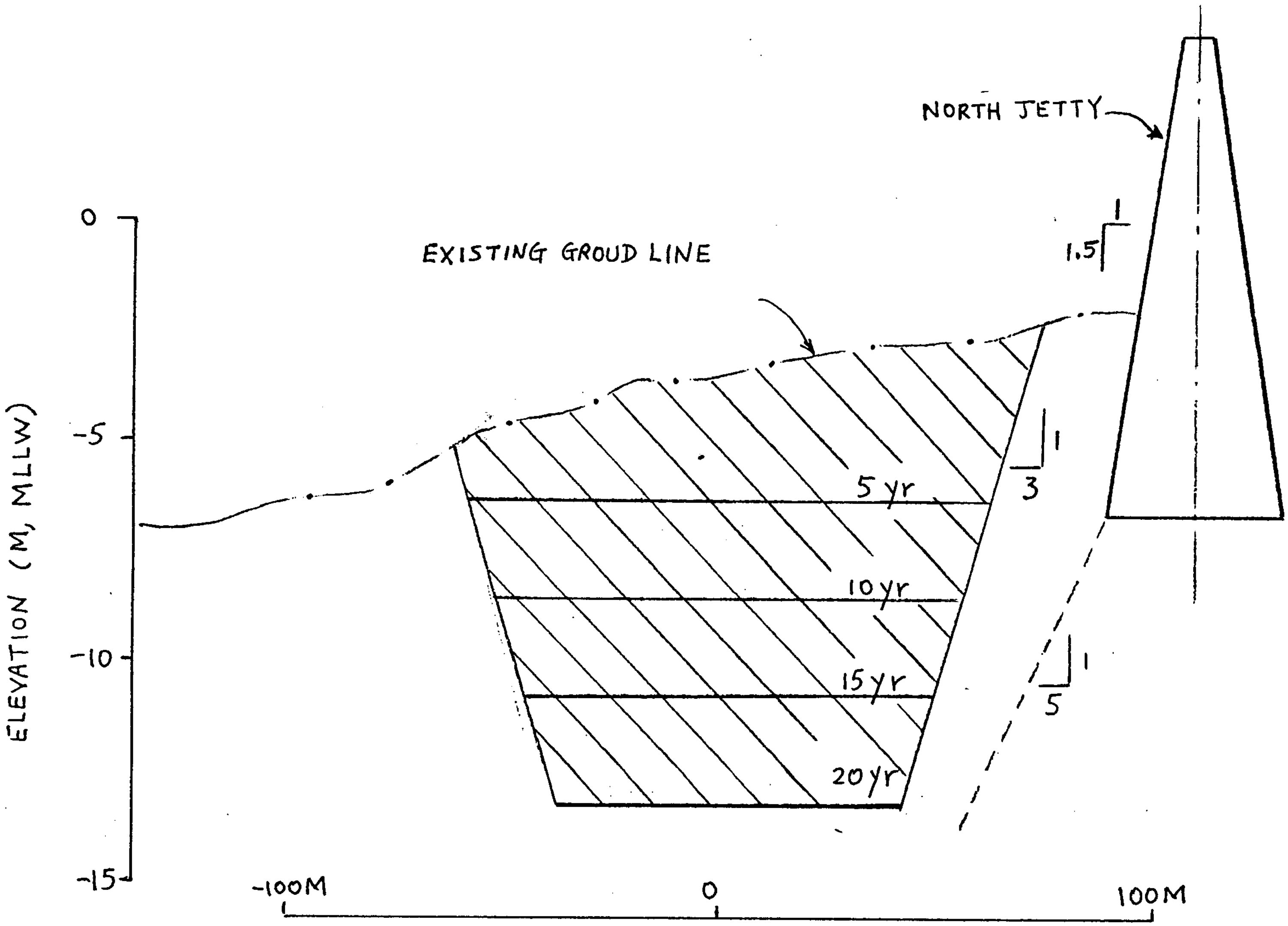
SECTION B-B (AREA B)

Figure 9



SECTION G-G (AREA G)

Figure 10 (a)



SECTION H-H (AREA H)

Figure 10(b)

Assumed Fate of Dredged Material

The *Dredged Material Management Plan – F3 Report* of the Marina del Rey and Ballona Creek Feasibility Study provided the following volumetric breakdown of entrance channel sediments that are classified as contaminated and beach/ocean compatible. The same sediment fractions and associated disposal options are assumed for this advanced dredged prism analysis.

Table 7 – Relative Dredged Material Volume by Sediment Quality Classification

Sediment Quality	Fraction (%) of Total Volume
Beach/Nearshore	35%
Ocean (LA-2)	20%
Contaminated	45%

Contaminated sediments were assumed for purpose of this study to be disposed at the proposed North Energy Island Borrow Pit (NEIBP) contained aquatic disposal (CAD) site located in Long Beach Harbor.

Comparative Cost Analysis

Unit Costs

Unit costs for dreding and disposal were based on information provided in the F3 Report previously referenced. Dredging disposal breakdown and associated costs are shown in Table 7.

Table 7 - Dredging Disposal Breakdown and Associated Costs

Disposal Method	Dredge & Disposal ($/m3)	Fraction (%) of Total Volume
Beach/Nearshore	4.5	35%
Ocean (LA-2)	11.5	20%
NEIBP	12.91	45%

A weighted average cost was calculated as follows:

$4.5\text{x}0.35+11.5\text{x}0.2+12.91\text{x}0.45 = \$9.70/\text{m}^3$

For each dredging scenario, the unit cost of $\$9.70/\text{m}^3$ was assumed. The Mob/Demob cost was $1,200,000.

Annualized Cost Approach

Annual cost were calculated over a 60-year period since it is the least common multiple for each of the dredging intervals evaluated, thereby offering a fair comparison.

Variables in the analysis included:

P = present value cost;
F = future value cost;
A = annualized value;
K = project duration;
m = number of dredging events in the project duration; and
i = annual interest rate.

The annualized cost over the project duration can be calculated as

$$A = P\frac{m(1+i)^K i}{(1+i)^K - 1} \quad (1)$$

Interest rate is given as 7.125%, project duration was assumed 60 years, equation (1) is simplified as

$$A = 0.0724mP \quad (2)$$

Cost Analysis Results

The annualized costs over a sixty-year period are shown in Table 8 and illustrated in Figure 11.

Table 8 - Dredging Event Cost and Annualized Cost

Dredge Frequency (yrs)	Total Volume (m^3)	Unit Cost ($/$m^3$)	Mod/Demob Cost ($)	Cost/event ($)	Number Dredging Events	Annualized Cost ($)
5	314,335	9.7	1,200,000	4,249,000	13	3,999,000
10	628,599	9.7	1,200,000	7,297,000	7	3,698,000
15	938,430	9.7	1,200,000	10,302,000	5	3,730,000
20	1,247,240	9.7	1,200,000	13,298,000	4	3,851,000

Among the four dredging intervals, ten-year dredging interval shows the smallest annual cost. The 5-year interval resulted in the highest annualized cost, although the difference between the two is only 8 percent.

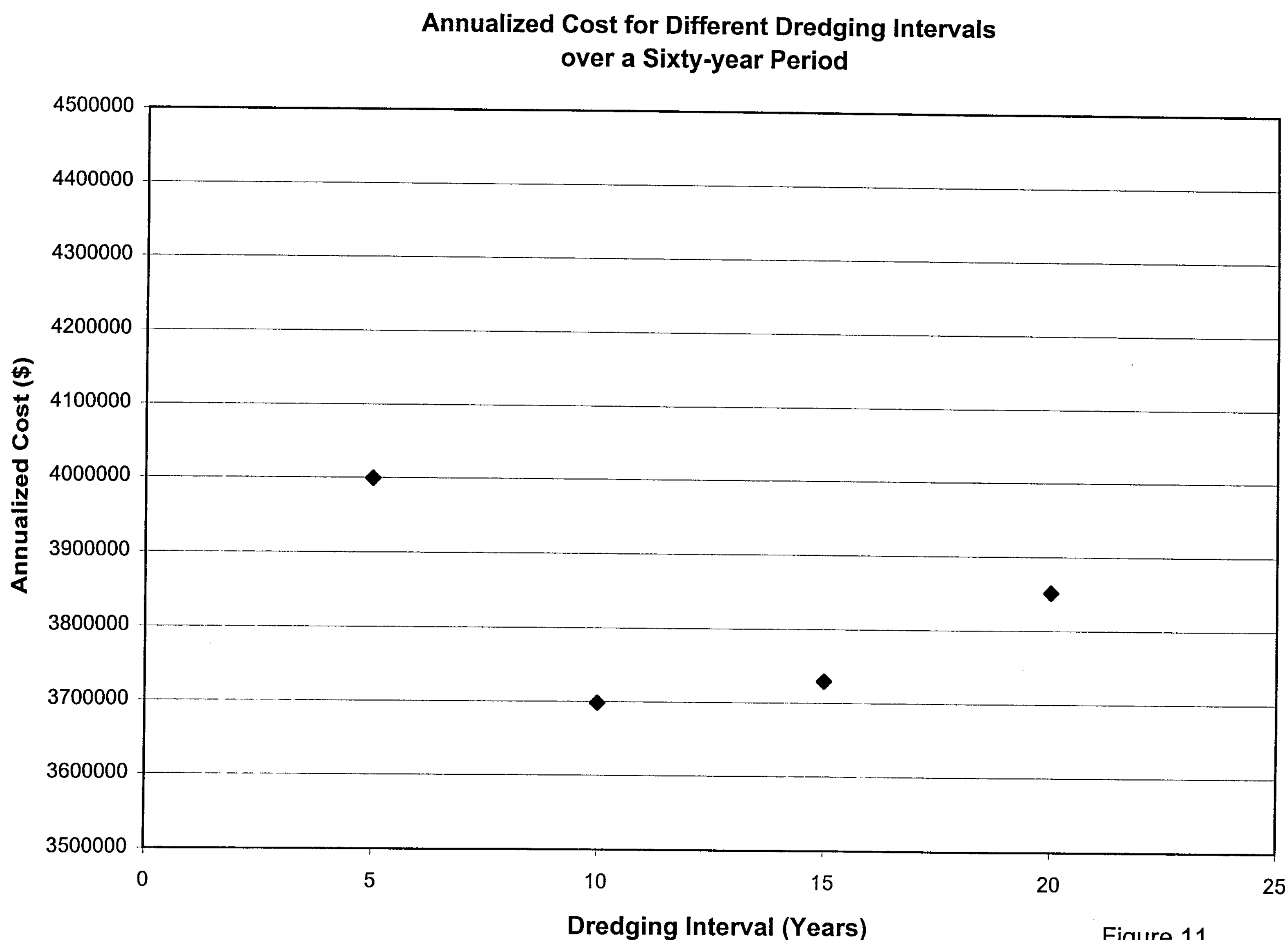

Annualized Cost for Different Dredging Intervals
over a Sixty-year Period
Annualized Cost ($)
4500000
4400000
4300000
4200000
4100000
4000000
3900000
3800000
3700000
3600000
3500000
0
5
10
15
20
25
Dredging Interval (Years)

Figure 11

SUMMARY AND CONCLUSIONS

The following provides a general summary and conclusions of the advanced dredging prism analysis.

1. The 10-year dredge cycle was estimated to be the least cost alternative. The dredge depths for Area A, B, G and H are –9.3, -9.7, -6.4 and –8.7 meters MLLW, respectively. These depths (except for Area G) are relatively close to the –9.1 meter MLLW advanced dredge depth scenario evaluated in the *Sediment Transport Analysis and Report.*

2. The 5-year dredge cycle was estimated to be the highest cost alternative. The dredge depths for Area A, B, G and H are –6.8, -7.3, -5.2 and –6.6 meters MLLW, respectively.

3. The cost variation between the least cost and highest cost alternatives was only 8 percent, which is within the range of accuracy of the analysis. Minor variations in the calculated shoal rate variations with depth could modify the final cost comparison.

4. Advanced maintenance dredging prisms were based on average annual shoaling rates, which are known to exhibit significant variability. A winter with greater than average precipitation and/or storm wave activity could significantly reduce the predicted dredging interval.